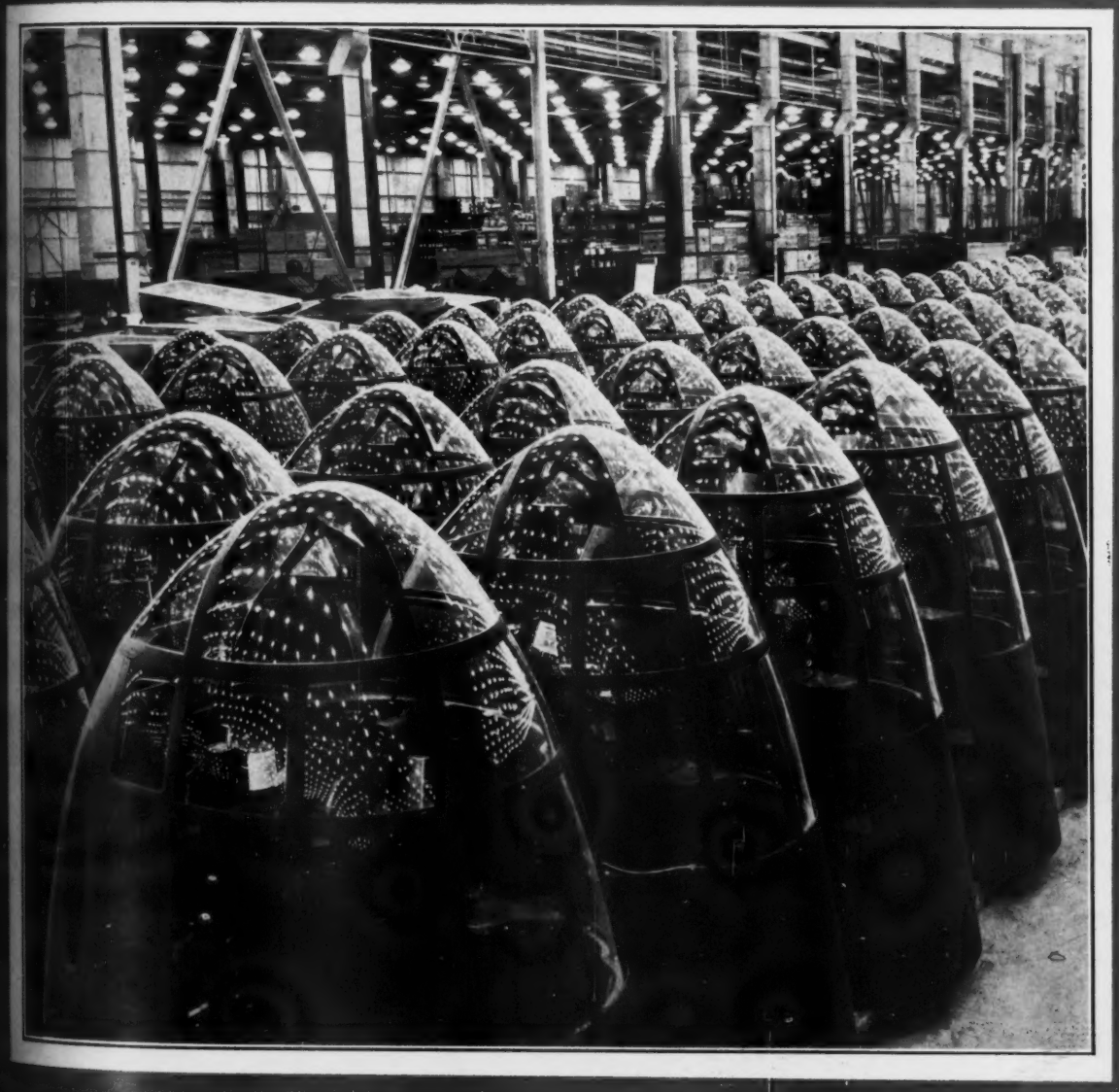
AERONAUTICAL ENGINEERING REVIEW

NOVEMBER 1943



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AERONAUTICAL ENGINEERING REVIEW

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Trail Blazing in the Skies

FIRST STREAMLINER BUILT ON AERONAUTICAL PRINCIPLES was the famous "Comet," designed and fabricated by Goodyear's Aircraft division in 1935 for the New York, New Haven & Hartford Railroad. In the Comet, lightness-with-strength was achieved by designing roof, sides and floor of the cars as main load-carrying elements of the structure — the same stressed-skin or monocoque construction widely used in aircraft. This undertaking was part of Goodyear's early work in exploring the possibilities of light aircraft metals that contributed to the development of the superior alloys in use today.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AIRCRAFT INDUSTRY

1. *By constructing subassemblies to manufacturers' specifications.*
2. *By designing parts for all types of airplanes.*
3. *By re-engineering parts for mass production.*
4. *By extending our research facilities to aid the solution of any design or engineering problem.*
5. *By building complete airplanes and airships.*

Engineering Development Work of the Consolidated Vultee Aircraft Corporation

EARL HOOSE

Consolidated Vultee Aircraft Corporation

Introduction

The merger of the Consolidated Aircraft Corporation with the Vultee Aircraft Corporation on March 17, 1943, brought together an unusual array of research and design talent. Consolidated Vultee now has at its disposal laboratory facilities and technical ability unequaled in the industry. The record of achievement of the engineering departments of this vast organization is being added to at an accelerated rate as the merged talent begins to function as one great development and design group under the able guidance of H. A. Sutton, Director of Engineering.

Many new problems confront the aircraft industry today. Most of these problems arise in the tremendous effort of surpassing the enemy in aircraft performance, effectiveness of armament, and production. Every major offensive, whether ours or the enemies', brings to light weaknesses or new enemy developments that must be overcome or surpassed. When weaknesses are overcome and enemy development surpassed, it is vital to produce immediately greater quantities of the improved aircraft. Consolidated Vultee's engineering talent is producing the solution to many such problems. The most notable recent developments have been in the field of testing technique and in the improvement of the physical properties of materials.

Predetermination of Aircraft Characteristics

Under existing conditions it is imperative that the finished experimental airplane equal or surpass the predicted performance. There is no time for long drawn-out flight research and extensive redesign. Insofar as possible, aircraft characteristics must be definitely determined prior to the start of the detail design of the experimental airplane. Out of this need for an infallible crystal ball has come the high development of models which duplicate the proposed airplane according to the characteristic to be determined. In addition to the complex wind-tunnel models Consolidated Vultee used throughout the industry our engineers have devised highly specialized models for determining the hydrodynamic characteristics of flying boats and the flutter characteristics of any type of airplane.

Towing Basin Testing

Model Construction

During the past three years development of towing basin equipment, technique of testing, and full-scale correlation of results have progressed rapidly. Design Staff Engineer Ernest G. Stout, of the San Diego Development Group, believed that many errors in hull design could be avoided through towing basin studies of the proposed design, provided complete dynamic similarity could be produced in the model. With his broad knowledge of model construction and his specialized experience with towed models as tools, he set out to develop a flying dynamic scale model for use in the towing basin. An intricate model was constructed from balsa wood in such a way that the weight empty of the model was distributed exactly as in the full-scale airplane. Internal construction fairly duplicated that of the prototype and a covering of $^1/_{10}$-in. balsa planking was provided. The thin balsa covering was made impervious to water through the application of rice tissue paper and a successive coat of varnish, making it far superior in this respect to the solid balsa models used in earlier British research. An ingenious method of providing scale lift was also developed. Stout developed, with the assistance of studies made by the N.A.C.A. and from repeated tests on the model while being towed through the air, a special full-span leading-edge slot that produced an extension of the lift curve of the model wing in such a way that its lift characteristics duplicated the characteristics of the full-scale wing for the same angles of attack. Since the aerodynamic drag of the wing had no bearing on hydrodynamic research, the resulting increase in this factor was not important. It was compensated for by increasing the power output of the motors enough to produce the scaled net thrust required to duplicate the thrust of the full-size power plant.

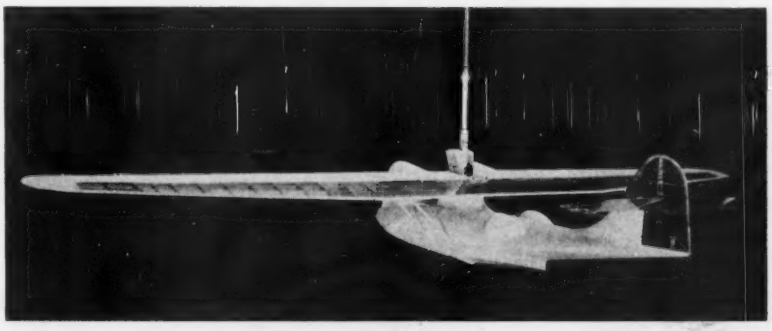
Model Power Supply

The power supply for the model was also a major stumbling block. No commercial product was available that would reproduce the power plant of the prototype. Consequently, Stout, in conjunction with the Sawyer Electrical Manufacturing Company, designed and developed a d.c. 15-kw. variable frequency induction alternator rated at 1.22 volts per cycle with a frequency range of 300 to 75 cycles for installation in the N.A.C.A. towing basin at Langley Field, Va. To power the model a special high-frequency polyphase a.c. air-cooled motor rated at $1^1/_2$ hp. at 6,000 r.p.m. was designed.

The motors presented an unusual cooling problem. Conventional cooling through the forward part of the nacelle, as on full-scale power plants, was not possible, because of the corrosion produced by salt spray entering with the cooling air. After considerable wind-tunnel research a reverse-flow cooling system within the nacelle with intake air ducts in the aft side of the wing slot was developed into an adequate solution. Motor temperatures were observed by means of a Wheatstone Bridge connected through the motor windings with the change in resistance calibrated in degrees. Thermocouples fastened to the inner walls of the nacelles are now used for this purpose.

Special Equipment

Several types of wood and plastic-bonded wood propellers were tried but



One-eighth-scale towing basin model of Consolidated Vultee Catalina, PBY. This is an earlier model which was equipped with windmilling propellers but was not powered.

When a parachutist takes his final exam both his diploma and his life depend on the fitness of his rip cord.

Lives also frequently depend upon the fitness of inconspicuous radio and electrical parts of Formica laminated plastic used in war equipment — such parts as insulating spools, insulating spacers, breaker arms, radio tube socket bases, terminal strips, rheostat cores and other insulating parts.

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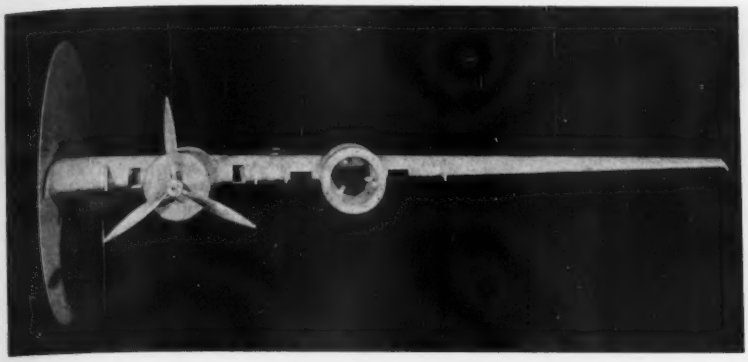


One-eighth-scale towing basin model wing, Consolidated Vultee PB2Y4. This half-span model wing was used in the wind tunnel to determine the effectiveness of the power-plant cooling system. Leading edge is removed revealing reverse flow system.

all failed quickly under spray tests. Finally, a special profile router was constructed to machine the propeller blades from heat-treated aluminum-alloy bar stock. Special balancing shears and a protractor were devised to balance and to set the blade angles of the finished adjustable pitch propellers. Electrically operated remote control for control surfaces was provided in the hull in the same manner as in the more advanced type wind-tunnel models. An electric trim indicator was also installed. Lead weights were suspended within the hull to establish the c.g. in its correct location for various arrangements of useful load, cargo, and crew.

Mounting the Model

With the model now complete in every detail, Stout set out to devise a method of mounting it on the towing basin carriage. The carriage is a 16-ton tubular steel structure having eight pneumatically tired wheels each driven by a 75-hp. motor and running on I-beam tracks. The carriage normally travels the 3,000-ft. length of the 24-ft. wide basin in about $1^1/_2$ min., but can attain speeds up to 88 ft. per sec. After much experimentation a rectangular shaft was mounted in a ball-bearing cage in such a way as to permit vertical translation of the model. The bearing cage was mounted on a set of ball rollers which moved on a fore-and-aft track mounted on the carriage, thus permitting relative movement of the model support with the carriage. A sensitive control in the carriage cab permitted the operator to adjust his speed to that of the model which was flying under its own power. Limit switches on the hanger track informed the operator of carriage speeds in excess of, or under, that of the model. By fastening the model to an axially rotating frame, freedom of roll was obtained. Freedom of yaw was obtained by hanging the rolling frame on a thrust bearing. Freedom of pitch was provided by fastening the thrust bearing to the square shaft with a transverse pin through the c.g. of the model. An adjustment device was installed to permit variation of the c.g. location.

Basin Testing Results

The long period of model development and the painstaking care devoted to all details bore fruit in the results obtained. Testing technique has been developed to the point where it is possible to predict accurately the isolated effect of c.g., elevator deflection, flap deflection, gross weight, and power loading (acceleration) on the hydrodynamic stability and spray characteristics of the airplane. Extensive full-scale taxi and flight tests involving over 200 runs have resulted in complete correlation between powered model and full scale. These studies have involved spray control, directional and longitudinal stability, and skipping tests. The towing basin tests have been duplicated exactly full scale, even to the point of making full-scale taxi runs with locked elevator positions to eliminate the pilot's inherent tendency to control small amounts of instability. An N.A.C.A. trim indicator in conjunction with a special sensitive low-speed pitot venturi, calibrated from 20 to 100 m.p.h., was used to obtain the trim tracks and oscillations from which the stability data were plotted. To make the studies complete, an important variable acceleration has been thoroughly investigated on a flying boat on which, at a beam loading of $C_\Delta = 0.89$, it was possible to obtain a power loading as low as 10.0 lbs. per b.hp. where take-off was possible at 15.0 lbs./b.hp.

With this work as a basis further development is under way to allow the model complete freedom so that it may operate as a free body without restraint. Thus it is becoming possible to predict accurately all phases of flying-boat hydrodynamic characteristics, which will result in improved operation of present designs and allow systematic development and improvement of hull lines in general.

Flutter Analysis

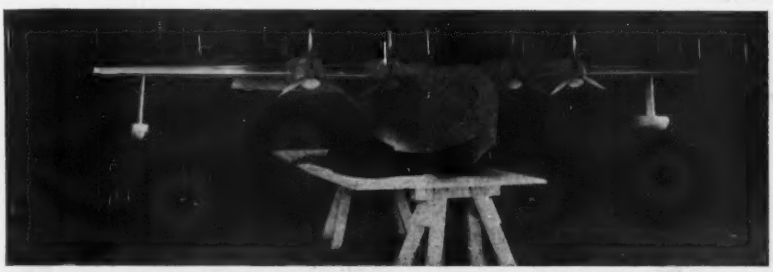
The problem of flutter analysis which has developed into an extremely complex mathematical study is also lending itself to solution through the use of models. The necessity for predicting the critical flutter speeds of airplanes with greater exactitude has become acute. Airplane sizes and operating speeds have increased to the point where the margins of safety between computed flutter speeds and the maximum design speeds are becoming increasingly smaller. As a consequence it has become necessary to re-examine the available conventional methods of flutter-speed prediction with a view to establishing the extent to which such methods can be depended upon to give reliable results.

Mathematical Treatment

The most successful and widely used method of attacking the flutter problem up to the present time has consisted of a mathematical treatment of the stability of a dynamic system made to approximate the airplane or airplane parts in question. In the past few years great strides have been made in the development of procedures and methods of applying this type of flutter analysis to practical aircraft structures. Nevertheless, the tendency has been toward further complication of an already complex problem rather than in the direction of further simplification. Moreover, confirmatory experimental data to justify existing theory have not kept pace with theoretic development, and the practical question of the extent to which the results of flutter analysis can be relied upon as indexes of the safety of the airplane still remained even after the most elaborate of analyses had been completed.

Experimental Testing

H. W. Pope of the Vultee Field Development Group, working in cooperation with the Army Air Forces, set out to bridge the gap between the experimental and the theoretic. This wedding



One-eighth-scale powered dynamic model of Consolidated Vultee Coronado, PB2Y4, used in hydrodynamic research in the towing basin at Langley Field, Va.

What every engineer should know about impact tests of plastics

THE growing use of plastics in important engineering applications has led to a growing emphasis on impact strength—and to more than a little confusion on the part of those used to dealing with strength data on metals and other materials. To help clear up this confusion, here are a few simple facts about methods used to determine and express impact strength of plastics.

Two different tests are common—the Charpy and Izod. A.S.T.M. at present favors the Izod and this is the method used by Monsanto.

HOW TESTS ARE MADE

In both methods, a test specimen is fastened in the path of a pendulum. The pendulum is swung, breaking the specimen, and the angle through which it swings is then read from a calibrated dial. This value, subtracted from the angle through which the same pendulum swings *without* an obstruction in its path, gives a measurement of the amount of energy required to break the test specimen and hence, of the specimen's ultimate impact strength.

In both methods, the test specimen is obtained from a solid, rectangular bar, 5" x ½" x ½", molded under specified conditions.

In the Izod method, however, this bar is cut exactly in half and the two halves notched at their centers. It is then held *vertically* at one end in a clamp and the blow is struck *on the notched face* at a carefully specified point close to the notch.

In the Charpy method, the entire 5" bar is used. It is notched at its center and is supported in a *horizontal* position at two points ½" from each end. The piece is struck *on the side opposite* the notch. Values obtained by this method average higher than those determined by the Izod test.

HOW RESULTS ARE EXPRESSED

Impact strength as determined by either Charpy or Izod methods is reported in three different ways:

1. *Foot-pounds energy to break*, the only value determined directly in the test.
2. *Foot-pounds per inch of notch*, obtained by dividing the value above by the width of the specimen.
3. *Foot-pounds per inch square*, obtained by dividing the foot-pounds energy to break by the cross section area below the notch.

As an illustration of the wide difference in figures for impact strength which results from these differences in reporting, the impact strengths of two representative Resinox phenolic molding compounds are reported below in all three ways:

IMPACT STRENGTH	RESINOX 4216 (A general purpose compound)	RESINOX 6952 (A high impact compound)
Ft.-lbs. energy to break	0.13 - 0.14	3.2 - 4.0
Ft.-lbs. per inch of notch	0.26 - 0.28	6.4 - 8.0
Ft.-lbs. per inch square	1.63 - 1.6	40 - 50

Obviously, the most important points for an engineer to remember in evaluating plastics for their impact strength is this: *be sure that the test methods used and the units in which results are reported are comparable*

HOW TO GET MORE FACTS

As one of the nation's largest manufacturers of plastics, Monsanto is interested in helping engineers get the facts on these relatively new and highly promising engineering materials. For further information on the versatile family of Monsanto Plastics, one of the broadest and most diversified group of plastics offered by any one manufacturer, write for the 24-page book, "The Family of Monsanto Plastics, a Guide for Product Designers." MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

THE BROAD AND VERSATILE FAMILY OF MONSANTO PLASTICS

(Trade names designate Monsanto's exclusive formulations of these basic plastic materials)

LUSTRON (polystyrene) . . . . . OPALON (cast phenolic resin)
FIBESTOS (cellulose acetate) . . . . . NITRON (cellulose nitrate)
SAFLEX (vinyl acetal) . . . . . RESINOX (phenolic compounds)

Sheets • Rods • Tubes • Molding Compounds • Castings
Vuepak Rigid Transparent Packaging Materials

MONSANTO PLASTICS
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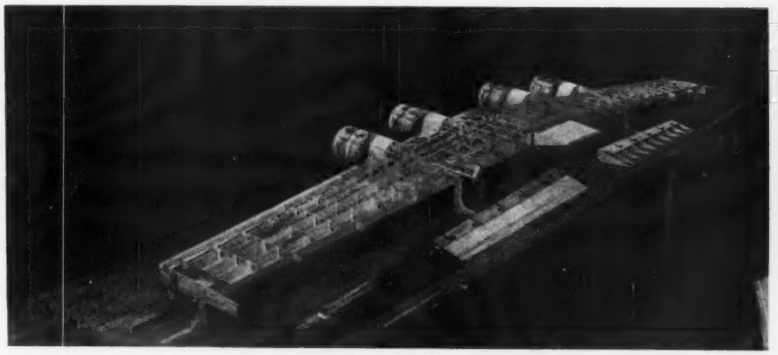
of the facts and the figures is being accomplished through the construction and testing of a dynamically similar wind-tunnel model of one of Consolidated Vultee's experimental airplanes. The fundamental practical purpose of such tests is to provide a reasonable assurance that a particular airplane will be free from destructive flutter oscillations throughout its entire flight range. The degree to which such a test achieves this purpose is, of course, dependent to a large extent on how accurately the airplane characteristics that are important from a flutter standpoint are reproduced in the model.



One-eighth-scale towing basin model wing, Consolidated Vultee PB2Y-4, skin, ailerons, and flaps removed. Lower surface shown. Scale at lower center is 24 in. long.

Theoretic Considerations

It is in this connection that the theory becomes of greatest value since it defines those parameters that have an important effect on the critical velocity and for which dynamic and geometric similitude must be maintained between model and full scale. In particular, it is necessary that the inertia and elastic characteristics of the model, expressed as nondimensional parameters of the mass, chordwise c.g. locations, mass moments of inertia, elastic axis and hinge-line locations, torsional and bending stiffnesses be identical with those of the full-scale airplane at all spanwise stations of the airplane wing or tail surface in question. In satisfying these criteria, it is found necessary to make the model differ in some particulars of its construction from a mere small-scale replica of the full-scale article if the critical speed of the model is going to be low enough to be obtained within the speed range of available wind tunnels.

With all of the important parameters of the full-scale article known, there is a variety of methods by which an equivalent or simplified structure can be made to satisfy the requirements of dynamic similarity. However, in general, the construction of modern airplanes is so redundant and so replete with access cutouts that the structural rigidity characteristics of the full-scale article are not readily amenable to analytic treatment; consequently, that type of model structure which differs from that of the actual airplane has the greatest chance of duplicating the actual airplane rigidity characteristics.

Special Model Construction

After considerable study, it was decided to build the model of a cellulose acetate plastic, duplicating in all reasonable detail the internal structure to the geometric scale, with the exception that the thicknesses of skin, webs, spars, ribs, etc., were increased in the ratio of the density of the full-scale material to that of the model. Thus, the correct similarity relations between the mass of the model and the full-scale airplane were maintained. Items of concentrated weight such as fuel, oil, pilot, equipment, etc., were simulated by small lead or pyralin weights attached to the structure in such a manner as to offer no additional contributions to the rigidity of the members.

To prove that the model satisfied the requirements of dynamic similitude, static and vibration tests were run to determine its natural frequencies, dynamic deflection curves, and static rigidities, and the data thus obtained were compared with similar data for the full-scale airplane. The check obtained was highly gratifying, the frequency ratio between full scale and model remaining constant within approximately 5 per cent of the mean for the six lowest vibration modes and within 10 per cent of the mean for the ten lowest vibration modes. A corresponding correlation was obtained between model and full-scale node-line locations, shapes of the dynamic deflection curves, and static rigidities.

Duplication of Conditions

Duplication of the free-flight-restraint conditions and aerodynamic damping characteristics due to rigid body motions was achieved by so mounting the model as to allow it freedom in roll, pitch, and vertical translation. Trim in roll and pitch was accomplished by means of adjustable tabs on the aileron and elevator. All tests were conducted near an angle of attack of zero lift to simulate conditions in a high-speed dive.

Forced vibrations were induced in the model and curves of amplitude of response for a given energy input obtained as a function of frequency and air speed for the critical motions under investigation by means of suitable electrical and optical recording equipment. The data thus obtained were used to calculate curves of damping versus air speed which served as an indication of the margin of stability against flutter at various air speeds.

The question of justification of the time and effort spent in testing was answered by the results obtained. A flutter condition that had not been previously anticipated was discovered and the proper preventive measures to apply were determined in advance of flight test of the airplane.

The test program was carried out to its logical conclusion by obtaining damping air-speed records of the most critical conditions during flight test of the airplane. By correlating the results of theory, wind-tunnel experiments, and flight test, it is believed that a more accurate basis for predicting airplane flutter speeds on future designs will result.

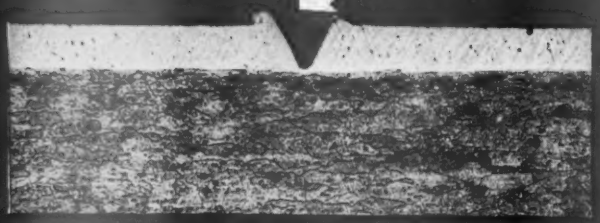
Test Possibilities

In this connection, the testing of an approximately dynamically similar wind-tunnel model in the early stages of an airplane design would seem to be of great value. The extent to which flutter must be treated as a primary design consideration can then be established while the airplane is still in a sufficiently formative state to allow any needed changes to be incorporated in the design. In fact, in the case of an unconventional airplane, a preliminary flutter model check might provide sufficient basis for deciding the soundness of the entire design. The results of tests made to date have been so satisfactory that similar and improved methods are being applied to a new design now under construction. It is anticipated that the results of the investigation of this new model will be available in time to incorporate any recommended changes prior to the time the design status becomes such that incorporation of the changes would cause a serious loss of time and materials.

Full-Scale Flight Testing

Through the higher development of models and testing techniques, Consolidated Vultee is finding it possible to produce, in a minimum of time, aircraft that equal or surpass requirements. However, in order to determine the accuracy and value of model studies it is necessary to carefully flight-test the full-size airplane. Not only is it necessary to check the flight characteristics of the ship but also the function of mechanical devices and equipment and the ability of the structure to withstand the loads imposed. The need for accurate flight-test data is thus readily recognized. However, the collection of these data has been extremely difficult. The test pilot's observations of the airplane have been proved to be unreliable, photographic recording has produced insurmountable problems of lighting and camera location, and simul-

Is this a "BAD" scratch?



Scratch in alclad coating, magnified 100 times. Observers agree that scratches seldom penetrate to this depth.

" ---- In case of Alclad Aluminum Sheet, this material will not be rejected for scratches that do not extend through to the base metal."

Plane production was accelerated when Government Specification Agencies announced the above decision on what constitutes a "safe" or "unsafe" scratch in alclad aluminum sheet. Contractors were given a usable standard of quality. Though made some time ago, it is repeated here for the benefit of any workers in aluminum who may not be familiar with the ruling.

Data on which this decision was based have since been supplemented by considerable new data. All confirm and strengthen the original findings. Typical results of the newer tests are shown in the table at the right.

Even the deep scratch, penetrating to the base metal, had no effect upon tensile and yield strengths, and only a negligible effect upon the elongation and fatigue strength.

It was again concluded, therefore, that scratches which do not penetrate through the alclad coating and into the core are not cause for rejection.

EFFECTS OF SCRATCHES ON TENSILE PROPERTIES*

Average Coating Thickness, In.	Average Depth of Scratch, In.	Average Depth of Scratch, Percent of Coating Thickness	Tensile Strength, Psi.	Yield Strength (Offset Equals 0.2 Percent), Psi.	Elongation in 2 In., Percent
0.0026	0	0	62 105	41 200	20.3
0.0025	0.00150	60	62 810	42 000	19.0
0.0028	0.00288	103	62 730	41 850	16.0

*All stresses computed on basis of full thickness of sheet.

Reprints of the paper, "Effect of Scratches on Fatigue Strength of Alclad Sheet", discussing these findings in detail, are available. For a copy, write ALUMINUM COMPANY OF AMERICA, 2142 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

taneous reading of instruments accompanied by manual recording has been virtually impossible. All of these problems increase in magnitude with the decrease in the size of the airplane and are greatest in high-speed single-place military aircraft.

The Vultee Radio Recorder

To surmount these obstacles the Vultee Radio Recorder was developed and Harvey D. Giffen of the Vultee Field Development Group has devoted much of his time to the perfection of this instrument.[1] The results of his work have been more than gratifying. The human element has been entirely eliminated from flight testing, simultaneous instantaneous reading of as many as 72 instruments is possible, the risk of the lives of valuable technical personnel has been eliminated, impending disaster is made evident in time to be avoided, data formerly impossible to obtain are readily available, records are not lost in case of accident, and recording goes on throughout the most severe and complex maneuvers. All this has been accomplished with little, if any, revision of the aircraft. It is only necessary to find a space in the airplane large enough to accommodate the converter unit, the scanning switch, and the pickup units.

Recorder Operation

The operation of the equipment by the pilot is quite simple. Having complied with the necessary preliminary requirements of the flight plan, he radios the ground station that the test is about to begin. The ground crew then sets the ground-recording equipment in operation and notifies the pilot that the test can proceed. The control switch in the airplane is then closed by the pilot, thus completing the circuit, and the scanning switch picks up the readings until the circuit is interrupted.

Continuous recordings can be made if desired. A recent study of tail buffeting used 14 strain gauges connected through a hand-selector switch in the pilot's cockpit. Continuous records of each strain gauge reading were made successively during buffeting conditions. The actual unit stresses in structural members such as the fin spar were obtained during the maneuvers. The duration of the load application was also readily determined.

With the present equipment Giffen and his men have recorded and analyzed the following physical facts: elongations through strain gauges; altitude; air speed; accelerations; manifold pressures; liquid pressures; air or gas pressures; pressure differentials; suction; liquid temperatures; air or gas temperatures; exhaust gas temperatures; fuel flows; revolutions per minute; control surface positions; flap, throttle, and other positions; and control cable or rod loads.

Development is proceeding on installations that will make possible the instantaneous recording of thermocouple readings, airplane attitude, hydraulic pressures, hydraulic valve positions, and vibration instrument readings.

"Celstrain" gauge attached to frame member of pressurized cabin. Note relative size and convenient narrow width.

The Vultee Radio Recorder developed and used by the Vultee Field Development Group has proved so satisfactory that a similar and improved installation is being made for the Flight Research Department at San Diego. Other uses are also being developed, particularly in the field of free-flight model work. Through the use of the recorder Consolidated Vultee has materially shortened the flight-test time required and has taken a long stride toward rapid transition from the experimental to the production airplane.

The Celstrain Gauge

The Celstrain Gauge, which has proved so valuable when used with the Radio Recorder, has acquired much of its versatility through the efforts of the Engineering Test Laboratories of the San Diego and Vultee Field Development Groups. Although the wire-resistance type of extensometer has been in existence for years, it has only recently been developed to its present usefulness. The gauge now in use is made from 0.0015 diameter strain sensitive wire. Special winding jigs have been developed which permit manufacture of the gauges in a variety of forms. Most common is the wafer-thin rectangular gauge made by sandwiching two parallel loops of wire between tissue paper and cementing the parts in place. Attachment of the leads is accomplished while the gauge is connected to a potentiometer, thus permitting control of the resistance. The standard gauge is made at 50 ohms, but special gauges have been made having resistances up to 400 ohms. The finished standard gauge is $^3/_{16}$ in. wide by $1^1/_2$ in. long and weighs 0.007 oz. The Test Laboratories manufacture their own gauges and have found that after attaining proficiency in the art a female laboratory technician can produce about 40 gauges per day at a cost of about 30 cents each. Gauges are scrapped with the test specimen since, at the low cost, salvage would be uneconomical.

The Celstrain Indicator

The Celstrain Indicator is used to read the gauges remotely. It has been developed to a fine degree of convenience and the standard instrument makes possible the reading of 60 gauges in approximately 5 min. Several indicators are used, each with its own operator, in taking data on tests involving as many as 200 gauges. The heart of the indicator is a light beam galvanometer used in conjunction with a simple Wheatstone bridge circuit. Compensation is made for variations in temperature which may affect the gauge readings during the test. The applications of the Celstrain principle are limited only by the ingenuity of the test engineer. Consolidated Vultee has used them in "decompression-due-to-gunfire" studies, in measuring stresses in windshield frames of pressurized cabins, stresses in structural members during flight maneuvers, pressure, accelerations, relative motion, control cable loads, and in measuring hinge moments of wind-tunnel and other models. Other developments are in work that will make available to the pilot and engineer data heretofore requiring extensive preflight computation.

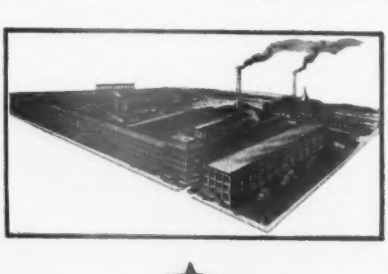
The Hydrotest Method of Wing Static Testing

The success of the Hydrotest method of wing static testing has been materially increased by the use of Celstrain gauges. In recent years wing loadings and corresponding deflections have increased to such an extent that sand-bag testing of full-span wings has become impractical. Other factors, too, have led to the development of a hydraulic method of loading specimen wings. It is no longer practical to construct special scaffolds, fill and weigh thousands of sand bags, train large numbers of personnel in team loading, or to risk injury to valuable personnel. Nor is it possible to obtain comprehensive, accurate data on the condition of the specimen when mechanical extensometers are nestled down among piles of sandbags and subject to accidental misplacement, vibration, impact, and erroneous visual reading in dark and inconvenient positions. To overcome these obstacles the Engineering Test Laboratories at San Diego developed the Hydrotest system of wing static testing. The system has been applied to two wings of more than 110-ft. span with allowance for tip deflections up to 50 in. Briefly, the method consists of fastening the full-span specimen wing to a steel fixture duplicating the wing attachments of the airplane, clamping chordwise rubber-padded formers at the necessary bulkhead stations, attaching a series of harnesses or linkages to the formers, and applying loads to the harnesses by means of a battery of hydraulic jacks. The hydraulic system used is necessarily a heavy-duty unit and was made

First in the Field...

In More Ways Than One

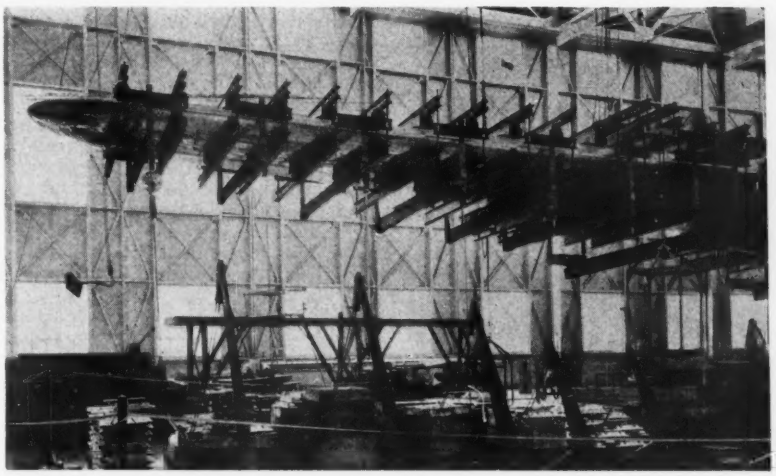
These aircraft engine parts, formed on automatic screw machines, require highly specialized progressive secondary equipment, and skilled workmanship. In *Hartford's* vast production are thousands of different precision parts that help make possible today's high-powered aircraft engines. • Established in 1876, *Hartford* manufactured the world's first automatic screw machines. Back in World War 1 *Hartford* made parts for Liberty engines. In 1925, when the drive started for precision in aircraft engine parts, *Hartford* pioneered parts for 410 H. P. engines. Today, we're making parts for the world's fastest 2,000 H.P. fighter engines. The ultimate in power and speed ... and so in greater precision ... is not even in sight • *Hartford's* background includes participation in every important development in screw machine product manufacturing and finishing ... From such a background flows the quality, precision, exactness and production uniformity so vital to war ... and post-war ... production • Facilities for additional production become available from time to time even now. And, when V-day comes, if you use parts that need the precision developed by *Hartford* for fighting engines, remember the first in the field. Hartford Machine Screw Company, Hartford, Connecticut.



★

HARTFORD

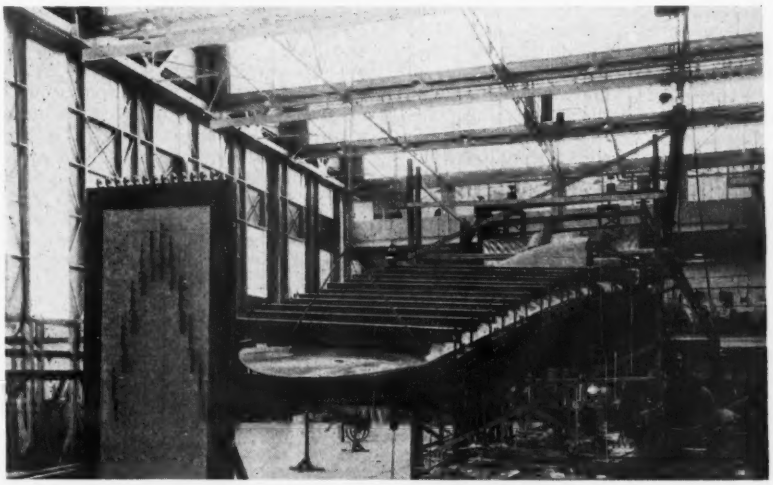
up from commercial snow-plow parts. All jacks are remotely controlled from one station by one test engineer. Wing deflections at various span stations are measured by means of a system of weights hung over a suitable chart at each tip. The weights are hung from wires that run through a simple pulley system to various spar stations. Stresses can be remotely and quickly determined by cementing Clestrain gauges at locations of interest. The advantages of this method of static testing far outweigh the somewhat higher initial cost. Accuracy of data, safety of personnel, saving of costly specimen repair through instantaneous release of loads at critical moments, versatility of test location, savings in preparation time and planning, and decrease in personnel requirements are some of the gains made through the use of the Hydrotest method.



Hydraulic jacks and harness system of the "Hydrotest" method of wing static test. Note drop-hammer dies and heavy ingots used to hold system to floor. This method eliminates elaborate subflooring and anchorages.

Measuring Surface Deflections

Although the Celstrain gauge is probably the most versatile product of the test laboratories, other important devices have been developed. Among these is the "Contour Pantograph." The device was specially developed for measuring deflections of surfaces under load. Its chief application has been in the measurement of deflection of windows in pressurized cabins. Curvatures and changes in curvature of any surface are measured to 0.001-in. accuracy and the contour is automatically plotted on graph paper. Deflections are magnified seven and one-half times and successive readings at various pressure increments can be taken without removing the instrument from the specimen.

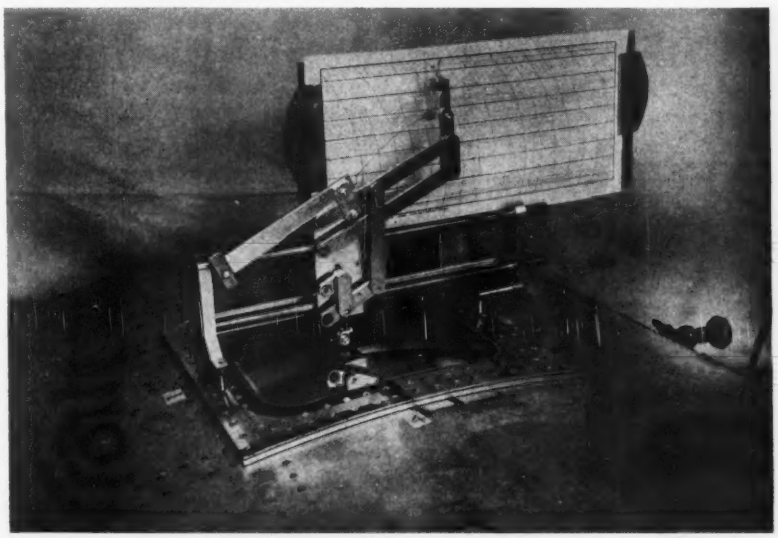


"Hydrotest" system applying 80 per cent ultimate design load to a wing of 110-ft. span. Note method of remotely indicating deflections.

Windows and Windshields

High-altitude airplanes have produced many problems that lend themselves well to solution in the laboratory. These problems are faced by almost every manufacturer of military aircraft. Glazing has proved particularly difficult. With the development of hot-air defrosting and deicing systems and more rigid specifications for visibility, methyl-methacrylate is no longer satisfactory as a window material. Since this material acts as an insulator, the temperature of the hot air required to defrost the outer surface reaches the temperature at which the plastic becomes soft (approximately 250°F.).

Pressure-type windshields for military aircraft present the additional problem of shattering due to bullet impact while pressure is applied. Since rapid decompression is injurious to the crew, it is important that the bullet or object leave a minimum hole instead of causing a complete blowing out of the panel. Results of an extensive test program prove that methyl-methacrylate does not meet these requirements. It was found that, at temperatures above −15°F. and at a pressure of 6.8 lbs. per sq.in., a 0.50-caliber bullet leaves a hole that could be tolerated. However,



Contour Pantograph measures the curvature or changes in curvature of glazing specimens.

Plastic-bonded laminated plate glass forms a strong glazing element but assumes strange shapes upon failure under pressure conditions.

temperatures as low as −70°F. are experienced at high altitudes and, at temperatures lower than −15°F. and pressures of 6.8 lbs. per sq.in. or greater, methyl-methacrylate does fracture and blow out.

Experiments were made with laminated methyl-methacrylate and polyvinal acetate. Some improvement was noted but large fragments still blew out when penetrated by a 0.50-caliber bullet under temperatures and pressure conditions of −37°F. and 6.8 lbs. per sq.in. The defrosting problem was increased and visibility was impaired.

Laminated Windows

With the cooperation of glass companies in gathering all available test data it was found that semitempered, laminated plate glass should meet all the requirements. This type glass consists of a layer of plastic sandwiched between two layers of semitempered plate glass. The test information available shows that this combination does not blow out when penetrated by a 0.50-caliber bullet. Any small fragments are pulverized. Hot air has no effect on plate glass and the plastic, sandwiched between, can stand higher temperatures since it is supported by the glass. The plastic can also be extended past the edge of the plate, allowing the advantage of using it for sealing purposes. The flexibility of this plastic also allows for slight variations between the glass and the mounting.

A number of tests were run on specimens approximately 15 in. square and formed to a radius of 57 in. Two plys of $^{7}/_{64}$ in. semitempered plate glass sandwiching a layer of 0.120 plastic were used. (See Fig. 1 for edge construction.)

Individual panels were mounted in a pressure box and withstood pressures as high as 26 lbs. per sq.in. at temperatures from 125° to −70°F.

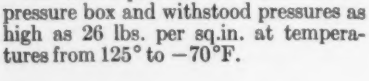


Fig. 1.

After these preliminary tests a full-size actual windshield was designed and constructed. The structure and mounting consisted of transverse and longitudinal tee extrusions. These members were arranged so that the average size of the glass panels was approximately 14 in. square. The transverse tees were continuous and circular while the longitudinal members joggled onto the transverse members (Fig. 2). The glass was formed to the contour giving it compound curvature.

Fig. 2.

Design and Construction

Since glass is difficult to form to a compound curvature, a tolerance of less than $\pm^{1}/_{16}$ in. in the contour is considered impractical. Variations will also exist in the mount; therefore, considerable strain is put into the glass when the mounting bolts are installed. The actual concentration of stress in the glass was examined by means of polarized light. Sharp changes of pattern were noticed during the process of tightening the mounting bolts. Since stresses are inherent in plate glass due to tempering and since additional stress is caused by the mounting bolts, it is evident that the fatigue of glass under constant strain is to a great extent the cause of breakage. Inconsistencies in test results led to the above conclusion. Cases were experienced where panels withstood pressures up to 6 lbs. per sq.in. on one run and then broke at 4 lbs. per sq.in. on the next run. A number of panels also cracked a few days after installation without any application of pressure.

To eliminate the major portion of the initial stress caused by the mounting bolts, glass of a new type edge construction was tested. This new type edge construction eliminates the $^{11}/_{32}$-in. offset and adds a metal reinforcing strip as shown in Fig. 3.

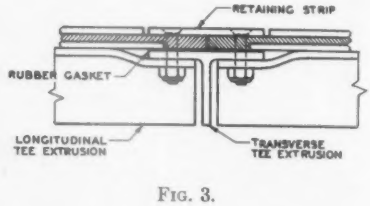


Fig. 3.

With this construction the plate glass was not trapped but was, to a large extent, free to take its natural contour. The metal strip tended to put some strain into the glass but less so than with the offset type glass. Even with the metal pliable enough to make up for discrepancies in the contour of the glass and mount, breakage still occurred at pressures of 7 lbs. per sq.in. However, the amount of breakage due to installation was practically eliminated.

To exhaust all possibilities of glass breakage due to improper mounting, particular care was taken to install the mounting bolts with equal tension. The plastic was softened by using infra-red lamps, and the nuts were tightened with a torque wrench exerting approximately 30 in.lbs. torque. This eliminated breakage due to installation; however, isolated cases of breakage still occurred at pressures above 7 lbs. per sq.in.

Since the deflection of the structure under pressure was within the tolerance of the allowable deflection of the glass it was not advisable to increase the rigidity of the structure because of the weight penalty. Increasing the thickness of the glass itself would have inflicted an even greater weight penalty.

Test Results

As mentioned before, stresses are set up in the plate glass during the semi-tempering process. This condition is worse in compound-curvature glass. In analyzing the test results it was evident that if some of this initial stress could be eliminated there would be a greater margin for the installation of the glass and consequently higher pressures could be attained. The glass companies cooperated by developing a new technique for tempering. This glass has been given severe tests up to 8.73 lbs. per sq.in. pressure without failure. Higher pressures will be attempted as soon as more important phases of the test have been completed.

As a result of tests to date it is recommended that the minimum thickness of semitempered laminated plate glass with compound curvature be held at two plys of $^{7}/_{64}$-in. plate glass sandwiching one layer of 0.120-in. polyvinal plastic. The edge construction as shown in Fig. 3 is the most satisfactory for sealing purposes and for variations in the contour of the glass and mounting. It is important that the bolts be installed with uniform tension. Concentrated loads in the structure which might cause even slight warpage should be eliminated.

Efforts are also being made to determine the relation between the shattering characteristics of various glasses and the rate of the accompanying decompression. A special setup has been developed to study the latter factor. The equipment consists of a large air-tight tube with a window of glass in one end. Celstrain gauges are used to determine the pressure drop in the tube upon shattering of the window. The rapid change in gauge reading is recorded by means of a high-speed motion-picture camera. From the photographically recorded data exact conditions during decompression can be established. It is expected these data will be used in further studies in the decompression chamber to determine the effect on personnel.

The B.F. Goodrich Airplane of the month

GRUMMAN HELLCAT

WATCH THE HEADLINES as the name "Hellcat" is written into the history of this war. You'll read it, and it will be good reading . . . for everyone but the Axis. For this sensational Grumman fighter—designated F6F—is our Navy's newest form of sudden death with wings. It's at home on land or on a carrier's deck. And like its famous predecessor, the "Wildcat," this new speedster will also be one of the British Navy's standard fighters.

We're proud that Silvertown Tires, De-Icers, Bullet Sealing Fuel Cells, and many other B. F. Goodrich products are helping manufacturers like Grumman make American warplanes the best in the world. To one of these planes, the Grumman "Hellcat," —our nomination as Plane-of-the-Month.

In war or peace

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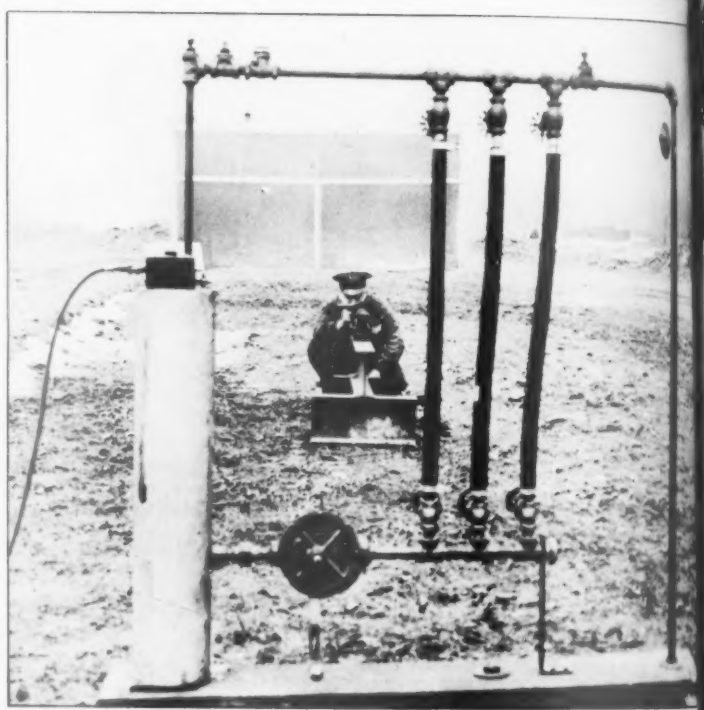
FIRST IN RUBBER

B.F.GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*



HE'S SHOOTING HOLES IN A HOSE...TO HELP BRING OUR FIGHTERS HOME

IT'S A mighty important hose he's shooting at, and it's mighty important that he score plenty of hits. For this hose is the vital link between an airplane's fuel tanks and its engines . . . a link whose failure due to bullet punctures, shell fragments, or any other cause could mean the loss of plane and crew. That's why he wants his 50 calibre bullets to hit and hit again . . . to see if the hose can take it.

And it can. This newest type of B. F. Goodrich Bullet-Sealing Fuel Hose has stood the firing tests both on the range and in combat. Time and again it has been shot up by 30's and 50's without fuel leakage. Actual cases are on record where good sized shell fragments have been found imbedded in the fuel hose of planes safely home from battle.

Back in 1941 was when B. F. Goodrich first began producing bullet-sealing fuel hose...following many months of development work. The original construction consisted of an Ameripol (synthetic rubber) tube, sealing layers, reinforcing plies, and an Ameripol cover. When gasoline penetrated the tube through any puncture, it caused the sealing layers to swell and thus seal the puncture.

Much research and many more developments followed, due to constantly changing performance requirements. The advent of aromatic fuel was responsible for one of the recent developments. This new fuel caused greater swelling and deterioration of the tube compound, hence construction utilizing an aromatic-resistant compound was needed. The first one developed did an excellent job of sealing at normal temperatures; but at the sub-zero temperatures encountered in arctic and high-altitude operations, its sealing effectiveness diminished.

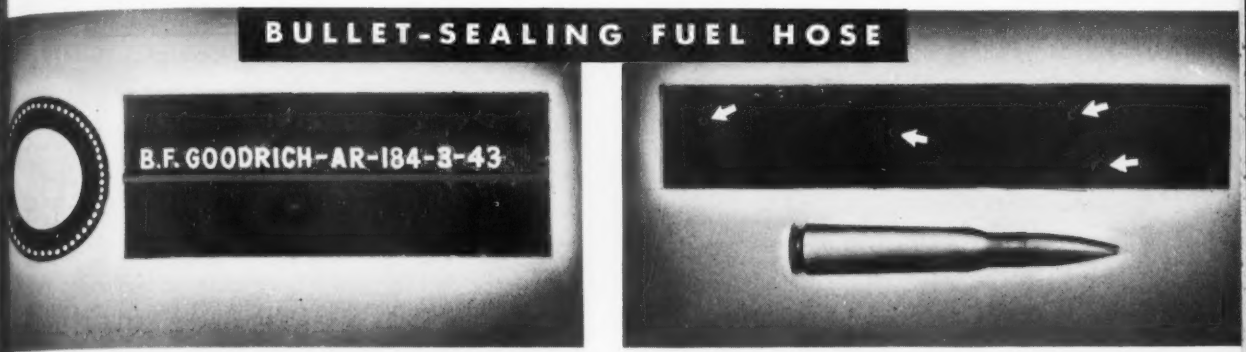
It therefore became necessary to develop still another construction utilizing a compound that would swell enough at sub-zero temperatures to seal efficiently yet not swell so much at normal temperatures that the inside diameter would be severely restricted. A construction of this type, with a few minor changes, has been in production since early 1942.

It is interesting to note that over 300 different constructions were made up and subjected to firing tests before today's efficient B. F. Goodrich Bullet-Sealing Fuel Hose was produced. And even now, B. F. Goodrich engineers continue their research, looking for still greater sealing efficiency . . . still greater protection for our combat fliers all over the world.

MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

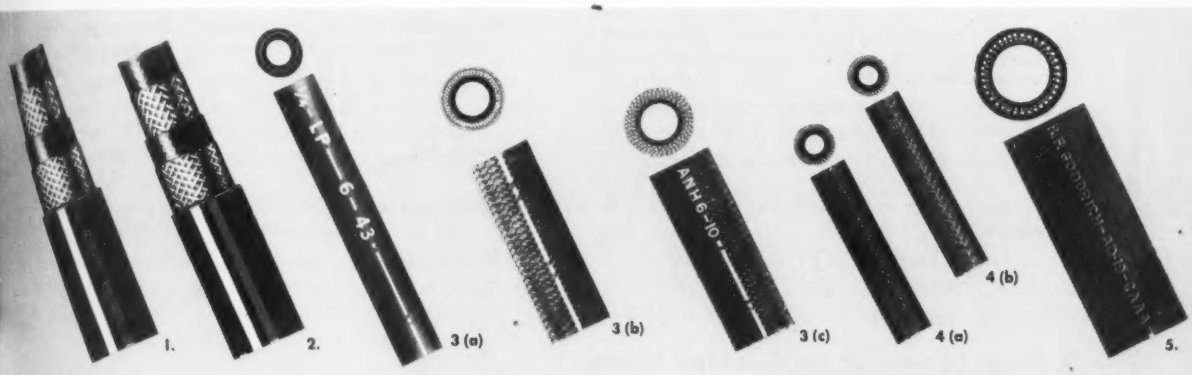
ARMY E NAVY
Awarded to seven plants

THERE'S AN EFFICIENT B.F. GOODRICH HOSE FOR EVERY AIRCRAFT APPLICATION



SCHEMATIC CROSS SECTION drawing of basic elements and side view showing identification markings. Designed for maximum sealing efficiency, this hose meets latest Army and Navy requirements and is approved for Army and Navy aircraft.

HERE'S PROOF of sealing efficiency: Although this small section of hose was punctured four times by .50 calibre machine gun bullets (shown in same scale below) it held fuel under 10 to 15 pounds pressure without leaking.



ALL B. F. GOODRICH HOSE CLEARLY MARKED FOR QUICK IDENTIFICATION

AIRCRAFT HOSE: All-purpose hose suitable for fuel systems. Meets latest revisions of Army-Navy specification AN-ZZ-H-456A. Identified by one broken red and one solid white stripe.

OIL AND COOLANT HOSE: Made with new neoprene compound to meet coupling conditions encountered in oil and coolant service. Otherwise similar to (1) above. Solid red and solid white stripe.

(a, b, c) **HYDRAULIC AND INSTRUMENT HOSE:** (Note: This group compounded for use in working conditions as low as -70° F. Identified by code ·-·- as B. F. Goodrich low temperature resistant.)

(a) **SPEC. ANZZH626A LOW PRESSURE INSTRUMENT HOSE:** For use on air, hydraulic, low pressure and fuel lines up to 40% aromatic.

(b) **SPEC. ANZZ623A HIGH PRESSURE HOSE:** Available both in synthetic and braided cover.

(c) **SPEC. ANH6a MEDIUM PRESSURE HOSE:** Air Corps standard for both medium and high-pressure service.

4. OXYGEN BREATHING HOSE: (a) Low Pressure—broken green stripe; (b) High Pressure—solid green stripe.

5. FIRE PREVENTIVE HOSE: For use ahead of engine fire wall in commercial planes. CAA-approved. Aromatic-resistant.

NEW DATA SHEETS AVAILABLE: Contain the facts you'll want (sizes, thicknesses, weights, lengths available, etc.) on the complete line of B. F. Goodrich Airplane Hose. For your free copy, write today (on company letterhead, please) to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

In war or peace

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FIRST IN RUBBER

GEORGIE GREMLIN WASHED OUT ON THIS

DE-ICER SERVICE QUIZ

CAN YOU SCORE 100%?

Complete the ten statements by simply picking the one correct part (a, b or c) following each numbered statement. See if you can get them all.

1. During every preflight inspection, De-Icers should be checked for punctures, loose patches and for freedom from oil because . . .

a. The crew chief says so.
b. Punctures admit too much sunlight.
c. It insures successful operation.

2. Soapstone or talc is applied between the De-Icer and wing skin . . .

a. To act as an insulator.
b. To fill in cracks.
c. To act as a lubricant.

3. Any oil found on De-Icers should be removed as soon as possible with a neutral soap and water solution because . . .

a. De-Icers don't need outside lubrication.
b. Oil is extremely harmful to rubber.
c. Someone might slip and break his neck.

4. If any damage to the De-Icer—large or small—is discovered . . .

a. Find out who caused the damage.
b. Make sure the hydraulic system is full.
c. Ground plane until De-Icer repair is made.

5. Except in emergencies, the standard B.F. Goodrich De-Icer Repair Kit should be used for surface breaks whose length is . . .

a. Three-quarters of an inch or less.
b. Three inches or less.
c. Five inches or less.

6. Only the materials in the B. F. Goodrich De-Icer Repair Kit should be used because . . .

a. De-Icers must be repaired with specially compounded rubber.
b. These materials are gremlin-proof.
c. Other materials are more expensive.

7. Whenever possible, a vulcanized repair is best for large surface breaks because . . .

a. A vulcanized repair uses less rubber.
b. It is stronger, neater and lasts longer.
c. It can be done quicker.

8. Adhesive tape is applied to the underside of each fairing strip's trailing edge to . . .

a. Prevent marring the skin of the airplane.
b. Carry inspection data.
c. Show manufacturer's code number.

9. For most efficient operation, the De-Icer pressure gauge should read 8 lbs. per sq. in. because . . .

a. This pressure keeps the plane balanced.
b. This pressure keeps oil flowing freely.
c. This pressure is necessary for proper inflation of the tubes without danger of rupture.

10. A complete cycle of De-Icer inflation should take approximately 40 seconds because . . .

a. Perfect timing shakes off chisel-jawed gremlins.
b. A 40-second cycle permits ice to form and be cracked off most efficiently.
c. A faster cycle might cause wing flutter.

WHAT IS YOUR SCORE?

Each correct answer counts 10. 1-c, 2-c, 3-b, 4-c, 5-a, 6-a, 7-b, 8-a, 9-c, 10-b.

FREE! Pocket-size booklet on De-Icer Servicing and Installation! Every trainee and instructor who works with De-Icers will want a copy of this interesting and informative booklet. Completely illustrated with step-by-step drawings, it shows the correct procedures for removing, repairing, storing and re-installing De-Icers. For your free copy of "De-Icer Service and Installation," write today to the B. F. Goodrich Company, Akron, Ohio.

B. F. GOODRICH, AERONAUTICAL DIVISION, AKRON, O.

Skyway or Highway

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FIRST IN RUBBER

Wherever **the Thompson Hot-Gathering and Forging Process is used in producing steel parts these parts are far less subject to fatigue under severe service than are parts made by cold-working.**

EXAMPLE:

21% STRONGER BECAUSE IT IS HOT FORGED

Thompson Bolts, used on aircraft where no ordinary bolt could safely stand the gaff—as main wing-attaching bolts for bombers, on landing gear, control surfaces, motor mounts—encounter every extreme in tension, vibration and bending loads. To meet these rigid service requirements, Thompson Bolts are hot-gathered in special machines and forged at red heat to achieve a grain flow in the metal that follows the contour of the forged head section. In tensile tests, the Thompson Bolt has proven 21%—nearly one-fourth—stronger than a comparable sized bolt made by ordinary cold-working methods . . . 21% more resistant to stresses . . . 21% better able to handle the tough assignments on fighting ships!

THOMPSON originally engineered this Hot-Forging method for use in making its world-famous engine valves. And to meet war needs it has extended the process to include a whole range of vital aircraft parts. The greater strength properties obtained from this method are found also in Thompson Airplane Engine Valves—Flash-Welded Hydraulic Pistons—Forged Exhaust Port Flanges—Control Rod Ends—Ball-Bearing Cable Ends—and Aircraft Bolts. Outstanding manufacturing control and care, seldom found elsewhere for similar parts, characterize the entire production technique used in making Thompson Products.

Your post-war plans may or may not be formulated yet—but if you have either a wartime parts problem, or are contemplating manufacture of products similar to those mentioned above, Thompson engineering ability, complete facilities, and over 40 years of experience are available. Write Thompson Products, Inc., WEST COAST PLANT, Bell, California.

This tensile-testing machine in the Thompson laboratory is only one of many types of equipment used in testing, checking and controlling Thompson Products during manufacture.

Thompson Products, Inc.

WEST COAST PLANT ★ BELL, CALIFORNIA

Simmonds-Hobson Automatic Engine Controls For Greater Efficiency and Engine Protection

COMBAT calls for split-second action. In the heat of battle at constantly changing speeds and altitudes, the warplane pilot has little time for careful adjustment of his engine controls. Modern engines can "take it," but at a sacrifice of their service life.

A welcome engineering advance toward more freedom for the pilot, and safer, more efficient engine operation, is the Simmonds-Hobson Automatic Engine Control—a "third hand" for the pilot. Units now in production for the United Nations' fighting aircraft provide automatic control of manifold pressure and mixture, maintaining a selected setting through varied maneuvers and altitudes. More advanced designs now under way will extend automatic control to propeller governor, spark, and other functions.

"Simmonds Equipment Flies With Every Type of Allied Aircraft"

- ★Automatic Engine Controls
- ★Push-Pull Controls
- ★Hydraulic Accumulators
- ★Equipment and Components for Hydraulic Systems
- ★Chronometric Radiosondes
- ★Spark Plugs
- ★Cowling and Panel Clips and Fasteners
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SIMMONDS AEROCESSORIES INC.

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Decompression Chamber Studies

Consolidated Vultee's decompression chamber at San Diego is one of the most complete installations in use today. Work in the chamber is under the direction of Dr. H. F. Helmholtz, Flight Surgeon. The chamber is used primarily to acquaint flight personnel with the conditions existing during high-altitude operation of aircraft and to instruct them in the proper use of equipment. It has also been so constructed as to permit the testing of instruments and other components of the airplane under high-altitude conditions. The chamber reflects the compromises necessary to versatility.

The unit consists of a steel cylinder divided into a main chamber and two locks: one for allowing individuals and large equipment to enter or leave without disturbing conditions in the main chamber and a smaller lock for handling small equipment. At the end of the main chamber is a small auxiliary chamber or test head which can be used as an additional or separate unit. The main chamber is uniquely insulated with 3 in. of cork applied to the interior of the steel shell. This insulation permits rapid refrigeration by the large three-stage freon system which has all its heat exchangers encased in a separate steel cylinder. The entire unit has been built and located in such a way that it can be readily enlarged should it, at some future time, prove inadequate.

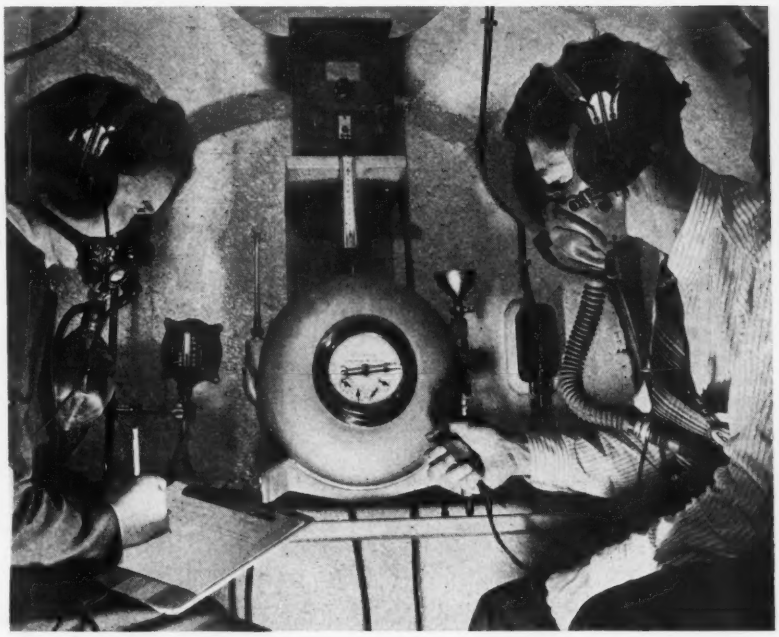
Personnel Training

The interior of the main chamber has been fitted with seats and complete oxygen and interphone systems for use in training or studying personnel. The unit is extensively used for three purposes involving personnel:

(1) Indoctrination—in which personnel are acquainted with the sensations of oxygen lack due to decreased atmospheric pressure, the proper use of oxygen equipment, what it will and will not do—and measures to be taken in emergencies are demonstrated. This is usually done in conjunction with a series of lectures on the problems of high-altitude flying. It is necessary to teach men what oxygen lack is like, for a person will become inefficient and even unconscious without realizing his danger. Oxygen lack causes the dulling of one's judgment of his own condition before it causes any discomfort of any sort.

(2) The re-creation of conditions under which personnel may have failed or gotten into difficulty. This is especially essential in determining causes of failure of oxygen masks and other oxygen equipment.

(3) The carrying on of research. Any measures designed to increase altitude tolerance in the human are, of course, worthy of study. At Consolidated Vultee Aircraft Corporation a small physiologic laboratory has been set up for study of any special problems arising in flight.



Laboratory Technician Marge Remmer and Test Engineer Phil Shaw check an oxygen flowmeter in "flight," in the Decompression Chamber.

Equipment Testing

With a chamber equipped to simulate conditions exactly at any altitude it is also possible to test a piece of equipment, its physical characteristics, and performance at any altitude without actually taking it out of the laboratory. In this respect the chamber has been of great value in research on high-altitude power plants.

Engine Design and Installation for High-Altitude Operation

The routine operation of standard aircraft at high altitudes has brought about the development of new features of engine design and a parallel development of engine installations. Consolidated Vultee is facing the same problems confronting other manufacturers of high-altitude aircraft. Considerable attention is being focused on duct design, fuel systems, and oil systems.

Ducting Systems

Both two-stage and turbosupercharger installations have resulted in power plants with quite complex ducting systems. If in the past it was the practice to consider ducting systems as a necessary evil and, consequently, to wind and twist them in wherever a little space could be found, this idea is fast disappearing. In fact, it is safe to say that the ducting now to no small degree designs the high-altitude power-plant nacelle and, in some cases, greatly influences the design of the airplane itself. Gains from careful attention to air duct design are twofold. Good ducting is necessary for obtaining as high a critical altitude as possible and is essential in the reduction of drag. It is becoming increasingly obvious that the internal drag of a power plant is an important part of the drag of an airplane. The high-altitude airplane has brought to general attention the fact that, to keep the internal drag of a power-plant nacelle to a minimum, pressure drop and the quantity of airflow through the various systems must be kept to a minimum. Duct losses on high-altitude airplanes become serious not only because of increased airflow but also because of the higher "V" squared losses due to reduced density. Whatever care is taken to produce ducts of low pressure drop will not only manifest itself in lower airplane drag but also in higher critical altitude. As altitude is increased, ram on the inlet to the supercharger means more and more in terms of critical altitude, not to mention the effect of efficient intercooling.

Heat Exchangers

Because modern high-altitude airplanes must operate under great variation of power, altitude, temperature, and velocity, the power-plant designer must select heat exchangers—i.e., oil coolers, intercoolers, and the like which will handle the most adverse possible combination of these variables. This means, in general, that under cruising conditions or high-speed conditions, especially at altitude, the ducting system is capable of furnishing much more cooling air than is necessary. To keep the quantity to a minimum, shutters or exit flaps are used. Shutters are effective from the standpoint of controlling the quantity of flow but do not satisfy the minimum drag requirement because of the high-pressure drop across the shutters themselves. A much more

...then perhaps he said to himself

A TEN-MONTH DELIVERY

MR. ROOSEVELT'S LETTER
President Roosevelt's letter to Mr. Churchill read as follows:
Dear Mr. Prime Minister:
When you were with us during the latter part of December, 1941, and the first few days of 1942, after we had become active participants in the war, plans for a division of responsibility between your country and mine became
Atlantic to your mills and and then, in form of ships, to send them back ports for the cargo waiting to be carried.
Materials and Time
Obviously, this would tailed a waste of mate time.
It was only natural to decide that this
Here there had been developed a welding technique which enables us to construct standard merchant ships with a speed unequaled in the history of merchant shipping.
well as in other matters, we agreed that mutual advantages were to be gained by concentrating, in so far as it was practical, our energies in doing those things which each of us was best qualified to do.
Here in this country in abundance were the natural resources critical materials.
Here we had waiting cargoes be moved in ships to your d and to other theatres. If country was to have carout its contemplated ship uction program it would been necessary to move onnages of raw materials have here across the
Our merchant larger and wi at a rapid ever-increasi sels we fore ties of no m your side t fleet has b you have i sequence licensed p
Clearly gant wa enced m used as p fail to w a waste side and portance facilitie

BIG PIECE OF NEWS the Prime Minister read to the House of Commons—the 10-months' delivery of a couple hundred ships.

Again the old formula: BIG name in the NEWS . . . made big by Big Production . . production made big by RECOURSE TO ARC WELDING (remembering Webster's short definition of RECOURSE as "a going to for aid or protection").

So the President has written the formula into the history of the world: "Here there had been developed a welding technique . . . with speed unequaled."

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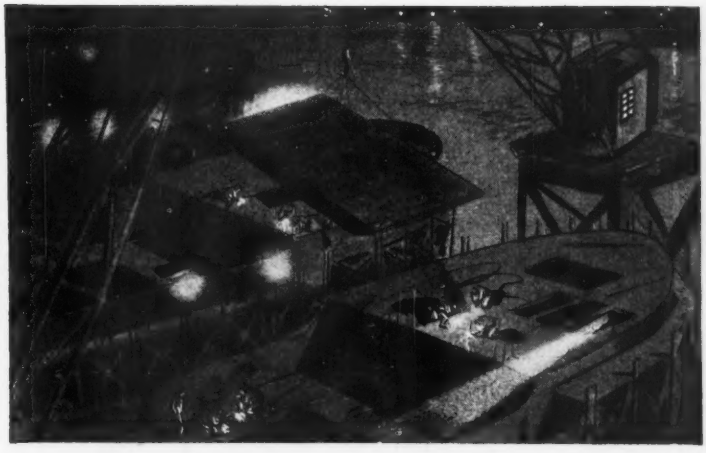
"A Welding Technique" *he said*

★ ★ ★ ★ *"with speed unequalled in the history of merchant shipping"*

...and this, Mr. Prime Minister, is what he meant:



SHOP FABRICATION. Ships welded on a production line by assembly line methods—faster welding by positioning the welding—pre-fabrication of large sections—upside-down assembly—dozens of short-cuts make up this technique, recourse to which has revolutionized shipbuilding.

MASS PRODUCTION. If ships can be put on a mass production basis, think of the speed and economy in producing products less bulky. If speed alone were the only benefit of welding, *recourse* to it might be debatable. But consider these additional benefits:

LESS STEEL
On these 200 ships, *recourse* to arc welding saves 375,600 tons. Steel is critical. Steel costs money.

LESS HULL FRICTION
A welded Liberty ship leaving New York would reach Sicily 40 hours quicker than its rough-skinned sister of equal horsepower.

INCREASED CARGO
18% more cargo carrying capacity is provided by weight-cutting through *recourse* to arc welding.

America's greatest natural **recourse**

ARC WELDING

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satisfactory arrangement is obtained with a controllable flap since, with a well-designed exit passage, a pressure recovery can be effected. Automatic operation of these flaps is desirable and many airplanes today feature automatic oil cooler flaps. It is expected that automatic intercooler flap control will be the rule rather than the exception in the future.

Fuel Systems

High-altitude fuel systems have presented a problem for some time. The addition of a booster pump at the fuel tanks has not provided a complete solution since it has been found that under given temperature, pressure, and flow conditions in some installations fuel flows drop off and even stop completely. To be reasonably certain that a given fuel system will operate satisfactorily, it is desirable to ground-test a complete mock-up of the fuel system under simulated conditions of climb to altitude. Through the use of tests of this nature, offending parts of the fuel system can be traced down and changed and a satisfactory fuel system from the standpoint of flow and pressure can be assured before the airplane is flown.

Fuel Vaporization

Another problem being investigated in the altitude-fuel system laboratory is the vaporization of fuel in climb. The realization that large percentages of fuel evaporate has aroused serious attention to the problem, both in the direction of pressurized fuel systems and the chemistry of gasoline. It is obvious that in the development of high-altitude airplanes the high-altitude fuel system laboratory is playing, and will continue to play, an important part, and test facilities of this type must be available to every manufacturer of high-altitude airplanes.

Oil Systems

While the need for ground testing of high-altitude fuel systems is quite generally accepted, the ground testing of oil systems is not as common. The complexity of the oil system in some installations is increasing quite rapidly with three or more accessories, requiring considerable amounts of oil and, in some cases, oil cooling, all being supplied by the main engine oil system. Added to this is the fact that some or all of the accessories may have a filter in the line both on the inlet side and the outlet side. At least three important flow problems present themselves to the designer of such an installation which make simulated altitude testing of the system desirable. They are:

(1) Considering 100 per cent efficiency of the suction oil pump, the pressure available for getting oil to the engine (or any accessory) from the tank is atmospheric pressure plus the head because of the tank's being above the engine (or accessory) oil inlet. Naturally, at altitude, the pressure available will be small, since in most airplanes the head due to differences in level is small. The first item, then, is to determine if oil flow can be maintained to the desired altitude. For safety, tests should be conducted substantially above and below the desired operating temperature limits. Items two and three cannot be considered separate problems—they are both part of the same problem but are separated merely for clarity.

(2) Oil foaming and aeration present a problem on which to date it has been difficult to obtain a quantitative answer. It is known that excessive foaming will produce engine failure. This is because the line pressure drop increases with increased foaming and the inlet pump efficiency drops off, plus the fact that aerated oil is not a satisfactory lubricant. Foaming increases with altitude so that the problem takes on a greater importance as airplanes are designed to fly higher. At the present time there is little knowledge as to the amount of foaming or aeration which will occur with a given engine at a given altitude. When this information is available the laboratory testing of oil systems will be of greater value, since then a definite quantity of foam can be produced and the system operated under those conditions. This is not to imply that bench testing at the present time is worthless without this information. On the contrary, a great deal can be gained concerning the problems surrounding foaming and the best ways to eliminate it. From these tests will undoubtedly come methods for accurate determination of foaming in flight.

(3) It has proved important to run bench tests to determine whether one line would tend to starve others on airplanes that were equipped with several accessories requiring fairly large quantities of oil where the accessories were supplied by branch lines from the main oil system. Conditions of acute starvation have existed in some designs and have been corrected before the airplane flew. The starvation was an altitude phenomenon and would not have appeared on a low-altitude airplane.

In view of the problems involved and the requirements of military aircraft it is evident that a more detailed consideration must be given to the design of ducting, fuel systems, and oil systems. It is also evident that much valuable data can be obtained through the use of the high-altitude laboratory.

Aluminum-Alloy Research

Most laboratory developments represent the solution to specific problems that unsolved would stand in the way of progress. Such developments are often produced in short time and quickly become so much a part of routine procedure that they are taken for granted. Less frequently, in industry a valuable advance is the result of pure research or an accidential discovery. In some respects Consolidated Vultee's contribution to the improvement of the mechanical properties of aluminum alloys lies in the realm of accidental discovery and pure research.

Early in the summer of 1937 and more recently in 1940 the test laboratories at San Diego were investigating the effect of heat on the mechanical properties of 24S-T aluminum alloys and on the color of its protective coatings. Such visual evidence is of value in determining the reduction of the mechanical properties of material and is sometimes applied to determining the safety of aircraft after accidental localized fires. In analyzing scorched specimens, Max Tatman, Metallurgist, noticed an increase in the mechanical properties of 24S material without a serious reduction in elongation. This increase seemed most interesting in the 350° to 400°F. temperature range.

Prior to 1937 it had been known that certain aluminum alloys responded favorably to a precipitation heat-treatment (artificial aging) but little, if any, attention had been given to improving the mechanical properties of 24S aluminum alloys through this means. It is probable that this omission was due to the fact that an improvement in yield and ultimate strength of 24S material through artificial aging is accompanied by a reduction in elongation and also to the fear that the heat-treatment would cause a marked reduction in corrosion resistance. Since Consolidated Vultee's first experiments in 1937, other data have been obtained as opportunity offered until in May, 1942, the development had advanced to the stage that it was considered desirable to discuss the artificial aging of 24S alloy with personnel of the Aluminum Company of America, and, subsequently, to present it to the Army Air Forces. The Army approved the process for Alclad 24S for use on their airplanes. Interest having been aroused, a great amount of work was done on the process during the remainder of the year by Roy A. Miller, Chief Research Engineer; and Max Tatman, of Consolidated Vultee; Alcoa; and others. Procedures were modified and extended to obtain the maximum mechanical properties with varying conditions of the material. Later the use of the improved material was approved by the Bureau of Aeronautics for use on Navy airplanes.

Precipitation Heat-Treatment

The precipitation heat-treatment for aluminum alloys is accomplished subsequent to the solution heat-treatment and consists in subjecting the material to temperatures between 350° and 400°F. for various time intervals at temperature, depending upon the chemical content of the material and the amount of cold work to which the material has been subjected.

The investigations of this process show that, in general, an application of 350° to 400°F. heat to 24S material reduces the ultimate and yield strengths and increases the elongation when the application is for a short interval of time. As the length of time at temperature increases, however, the ultimate and yield strengths increase and the elongation decreases to some minimum

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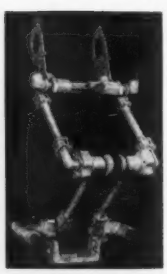

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that does not appear to vary further with time at temperature. The ultimate and yield strengths, however, reach a maximum value with some certain time at temperature and thereafter again decrease. The time at temperature to reach the maximum values of ultimate and yield strengths depends upon the temperature and upon the amount of cold work that has been performed on the material prior to the aging treatment. It is interesting to note that the effect of the aging treatment on the strength of the material is additive to the effects of cold-work but to a lesser extent when the cold-work is performed subsequent to the aging heat-treatment. The artificial aging also tends to equalize the yield strengths—i.e., if the cold-work is in tension which results in a compression yield somewhat less than the tensile yield strength, the artificial aging treatment, if prolonged to yield maximum mechanical properties, will increase the compressive yield to a greater extent than the tensile yield so that the two again become approximately equal.

24S Processing

Service approvals, to date, apply to the processing of Alclad 24S sheet only. Data obtained with this material apply to sheet with 5 per cent of pure aluminum cladding on each side of the 24S core. As stated above, the maximum values of the mechanical properties can be obtained with various combinations of temperature and time at temperature. However, as the temperature is increased, the time at temperature becomes more critical. It is therefore intended to use a longer period of time and a more moderate temperature which will facilitate production control of these aged materials.

It is also desirable to age at a longer time at temperature in order to avoid any appreciable reduction in the corrosion resistance of the material. For example, tests conducted by the Aluminum Company with plain 24S-T sheet showed that at 375°F. aging temperature the maximum strength in tension was obtained at 6 hours and the maximum yield strength at 9 hours. However, the maximum reduction in corrosion resistance occurred at 1 hour, after which the corrosion resistance improved directly with aging time until at 11 hours it was again normal.

The mechanical properties of aged Alclad 24S sheet with various amounts of cold-work prior to the artificial aging heat-treatment are shown in Table 1. In all cases the aging temperature to be used in obtaining these values is 365°F. plus or minus 5°F.

Miller and Tatman are continuing their research on the improvement of the physical properties of aluminum alloys. Consolidated Vultee has prepared a system of nomenclature by which the improved material is identified and is putting the necessary shop process instructions and specifications into effect.

Appreciable savings in weight are realized through the use of artificially aged aluminum alloys. When these savings are augmented by improved methods of stress analysis it is expected that a marked increase in aircraft performance will result.

Mathematical Analysis of Structures

Typical of the advances made in the mathematical analysis of structures is the work of Henry Langhaar and others on the design of the web system of plate girder beams.

Web systems of plate girder beams have been successfully designed and built for many years. The web plate of the earlier plate girder, however, was assumed to be, and generally was, of sufficient thickness and strength so that it did not buckle under the loads to which it was subjected. The material in the web plate was therefore considered to be in simple shear only, the bending being assumed to be carried by the flange angles and the cover plates. Plate girders designed with these assumptions and by the formulas in the textbooks gave satisfactory service.

With the advent of metal construction in aircraft, however, the necessity for minimum weight in the structure in most cases precluded the design of a girder web to resist the design loads without buckling. A theory and method of design was then developed by Wagner for the case of a buckled plate-girder web. This is known as the diagonal tension theory. This method, however, does not consider the shear that may be carried before buckling occurs and makes no provision for the shear that is carried by the flange or bending material after buckling. The latter omission is important, especially with wings of stiffened sheet construction where a more correct calculation of the distribution of the shear in the wing covering and spar webs may result in a substantial weightsaving.

Table 1

Alclad 24S Sheet Mechanical Properties

	(1) No Cold-Work		(2) Typical 24S-T		(3) 24-RT		(4) Typical 24S-RT	
Mechanical Property	After solution heat-treatment	After artificial aging	As received	After Artificial aging	After cold-work	After artificial aging	As received	After artificial aging
Tensile strength	56,000	62,000	62,000	65,000	65,000	67,000	66,000	70,000
Tensile yield	38,000	46,000	45,000	57,000	51,000	63,000	50,000	66,000
Compression yield	38,000	48,000	40,000	57,000	44,000	64,000	50,000	66,000
Elongation	13–16	10	18	6	14	6	11	5
Shear strength	37,000	39,000	39,000	40,000	40,000	42,000	41,000	42,000

Note:

(1) The mechanical properties in lbs. per sq.in. shown under "after artificial aging" are, in each case, minimum values. Typical values will be 2,000 to 3,000 lbs. per sq.in. greater. These data apply only to Alclad with the surface cladding 5 per cent thick on each surface.

(2) Under (1) the sheet has had little if any cold-work prior to the aging operation which consists of 9 to 10 hours at 365°F. This material is designated as 24S-T80.

(3) Under (2) the sheet has had more or less cold-work due to stretcher leveling or roller leveling operations after the solution heat-treatment. The aging operation consists of 9 to 10 hours at 365°F. This material is designated as 24S-T81.

(4) Under (3) the sheet is given the solution heat-treatment and then stretched to a set of 3.5 per cent. The stretching operation follows the solution heat-treatment at a time interval of 1 to 24 hours. This cold-working operation has been used at Consolidated for some time to improve the compressive yield strength of the drawn-hat and zee-stiffener sections formed from strip stock and used in building our wings, stabilizers, hulls, and fuselages. The aging operation consists of 8 to 9 hours at 365°F. This material is designated as 24S-T84.

(5) Under (4) the sheet has had considerable cold-work. The aging operation consists of 7 to 8 hours at 365°F. This material is designated as 24S-T86.

(6) The aging operations outlined above do not appreciably affect the corrosion resistance of the material except that there is a slight tendency to stress corrosion cracking in the core at the edge of the sheet when subjected to stress and corrosive media. This stress cracking may be prevented by an anodic treatment or by the application of an approved primer to the edges. Contrary to the effect of the rate of cooling from the solution heat-treatment temperature, the rate of cooling from the artificial aging temperature does not affect the corrosion resistance of this material. Therefore cooling may be done in cool water or in air at room temperature.

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As a result of an early investigation at Consolidated which included the destruction testing of a large number of plate girder beams, a design procedure was established that included provision for the effects of the shear carried by the web plate before buckling, the shear carried by the web plate after buckling, and the shear carried by the flanges. The ultimate shear strength of the beam or spar was expressed by the following formula:

$$V_u = (V_{cr} + V_{tu})\ (I_F/Qh) \qquad (1)$$

where

$V_{cr} = f_{cr}ht$

$V_{tu} = \left(1 - \frac{f_{cr}}{C_r F_s}\right) F_{tu} R h t C_r \sin\alpha \cos\alpha$

I_F = the moment of inertia of the flange material about the beam neutral axis

Q = the static moment of the material in one flange about the neutral axis of the beam

h = the web plate effective depth, generally taken as the vertical distance between centroids of the flange rivets

f_{cr} = unit shear stress at web buckling as determined by the formula $f_{cr} = K_s E(t/b)^2$

t = web plate thickness

C_r = correction factor for the flange rivets or the rivets in the web stiffeners

F_{tu} = the ultimate unit tensile strength of the web plate material

F_s = the ultimate unit shear strength of the web plate material

R = the Wagner constant for diagonal stress distribution in the sheet

α = the Wagner diagonal tensile stress angle

The resultant flange rivet load in pounds per inch of span was determined to be as follows:

$$P_R = \left[\left(\frac{V_{cr}I_F}{hI_w} + \frac{V_{tu}}{h}\right)^2 + \left(\frac{V_{tu}\tan\alpha}{h}\right)^2\right]^{1/2} \qquad (2)$$

where I_w equals the moment of inertia of the entire beam cross section about its neutral axis. The other symbols have the same significance as shown above.

The design of the vertical stiffeners, riveted to the web to delay buckling, was found to be best determined by using as a criterion the moment of inertia of the stiffener about the axis of its cross section parallel to the web plate. The necessary moment of inertia is calculated by the following formula when the web plate is not shear resistant.

$$I_s = 3.4V^{2.5}b^2/10^{15}t^2h^3 \qquad (3)$$

where V equals the total shear in the web plate and is equal to $V_{cr} + V_{tu}$. The other symbols have the same significance as shown above.

When the web plate is so designed that it will not buckle before reaching the design load (shear resistant), the following conventional formula is used:

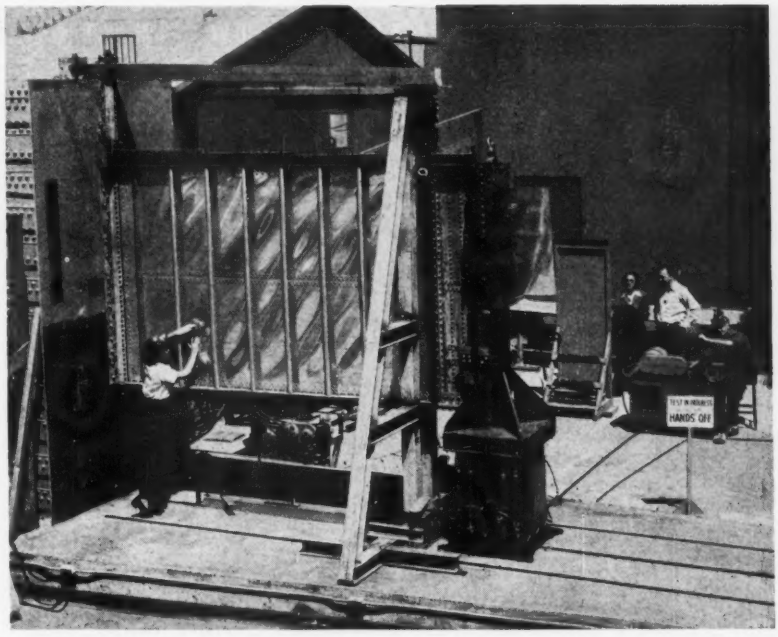
$$I_s = \frac{2.29b}{t}\left(\frac{V_{cr}h}{33E}\right)^{4/3} \qquad (4)$$

The formulas shown above have been checked by a large number of full-scale tests including a wide range of sheet thicknesses, beam depths, and stiffener spacings. Their use for design purposes gives satisfactory results except that, since the stiffener spacing increases until it approaches or exceeds the effective depth, the formulas become somewhat conservative. Inasmuch as they make provision for the effect of the flange material in carrying the shear loads, their use is especially important with stressed-skin wing construction as the spar weight is thereby kept to a minimum. The use of the above formulas has been approved by the Services and the formulas are now included in many textbooks for aircraft structures.

In order to eliminate the conservatism existing in Eqs. (1) and (2) as the ratio of the stiffener spacing to the beam effective depth approaches or exceeds 1.0, the above method has been modified to give the equations shown below. In the case of the web system so designed that the plate is shear resistant at the ultimate design load, the allowable unit shear stress would be:

$$T_{su} = 0.9[1 - (d_s/P_s)]F_{su} \qquad (5)$$

where F_{su} equals the ultimate shearing strength of the web plate material, d_s equals diameter of the web rivets, and P_s equals pitch of the web rivets.



Measuring web wrinkle angles during a test of the plate girder design method described herein. Note battery of jacks and size of beam. This specimen is typical of spar depths required by Consolidated Vultee experimental airplanes now being constructed.

In the case of a web system so designed that the web plate will buckle before the ultimate design load is reached —i.e., it is not completely shear resistant—the allowable unit shear stress would be:

$$T_{tu} = (RR_rF_{tu} + T_{cr})\sin\alpha\cos\alpha \qquad (6)$$

where

R = an empirical correction factor for the stress distribution in web plate

R_r = a rivet hole stress concentration factor

F_{tu} = ultimate unit tensile strength of the web plate material

T_{cr} = unit shear stress at web buckling as determined from the formula $T_{cr} = K_s E\ (t/b)^2$

α = the angle of principal stress

The angle of principal stress may be determined from the following equations, though in practice, a chart of tan α in terms of r and λ facilitates the work. The general equation is:

$$(\lambda + 1)\tan^3\alpha = \frac{1 - r\tan\alpha}{\tan\alpha - r} \qquad (7)$$

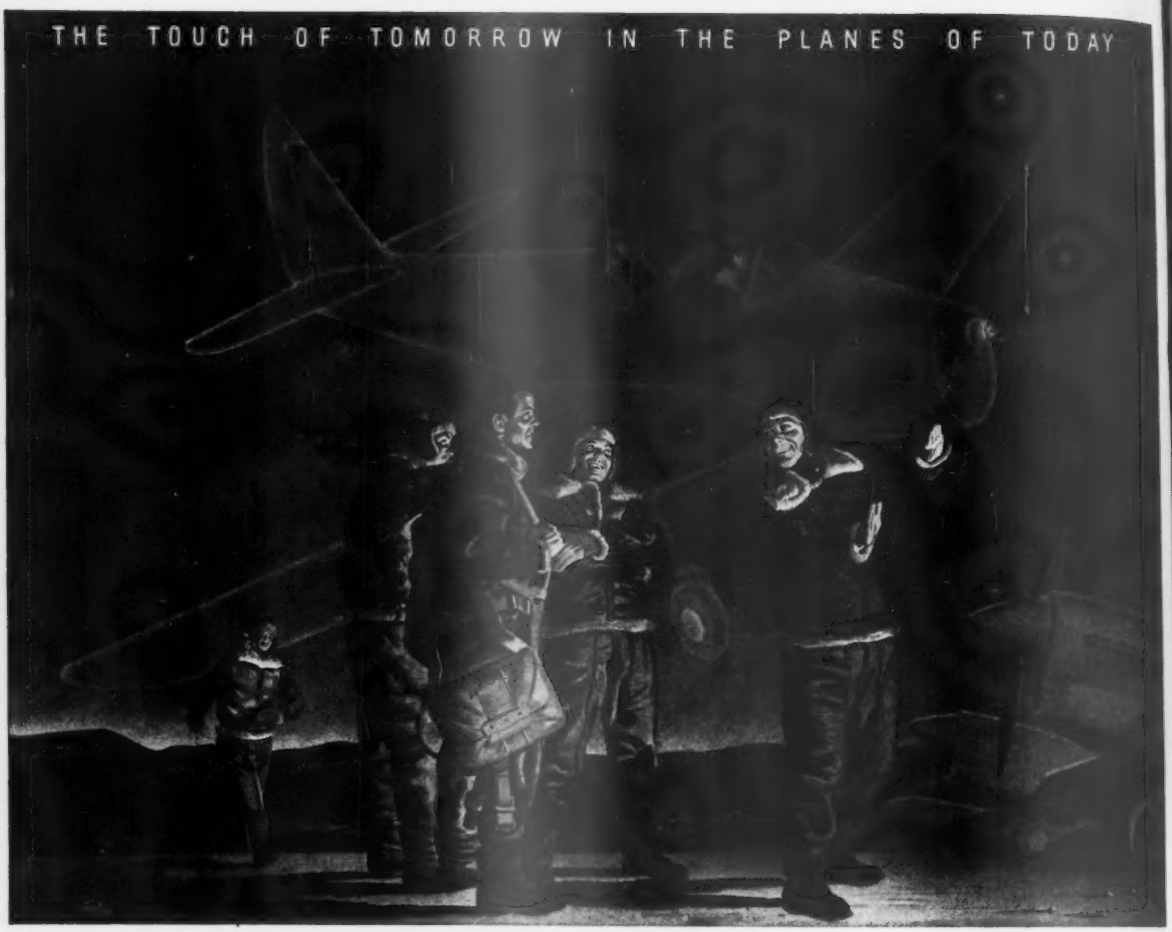
where

$r = T_{cr}/T$

$T = V/h't$, the ultimate or design unit shear stress in the web plate, assuming uniform stress distribution between the flanges

h' = vertical distance between centroids of the flanges

(*Continued on page 177*)



Reunion on the Field of Battle

These are Fairchild alumni—fighting men from Norway, Canada, the U. S. A.

Though they come from different parts of the world, these skillful warriors of the United Nations Air Forces have much in common.

Typical of thousands of fliers on every fighting front, each was given an intensive course in a Fairchild Primary Trainer as one important step on the road to winning his wings. Their meeting upon some distant airfield is virtually a reunion of "old grads" of the same Alma Mater.

It is easy to understand why the Air Forces choose Fairchilds for primary training.

There is the element of added safety. For example: quick take-offs and steep climbs can be performed by novices in a Fairchild Trainer without danger of stalling, which caused so many fatalities in the last war. The trainee, behind a 175 or a 200 horsepower Ranger engine, just "pours on the coal" and he's quickly in the air with a lot of runway to spare.

And when it comes to acrobatics, which give a trainee an intimate feel of the controls and teach him instinctive flying, a Fairchild is the answer to an instructor's prayer. No need to crush the student's confidence by telling him not to dive at high speeds. Just teach him all the tricks in the bag, with the full knowledge that safety has been built into every inch of every Fairchild Trainer.

Maneuverability with great safety, and rugged landing characteristics—for which *all* Fairchild trainers are famous—provide the foundation stone of Fairchild's "touch of tomorrow in the planes of today."

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Fairchild Aircraft

Division of Fairchild Engine & Airplane Corporation, Hagerstown, Maryland.....Burlington, North Carolina

A Study of the Volumetric Efficiency of a High-Speed Engine

JOHN MARKELL, JR.,* and C. FAYETTE TAYLOR†

Massachusetts Institute of Technology

John Markell, Jr.

ABSTRACT

This is a report on experiments made at the Sloan Laboratories of the Massachusetts Institute of Technology to determine the effect of certain operating variables on the volumetric efficiency of an internal combustion engine.

The engine used was a Ford V-8, 1940 model, connected to an electric dynamometer and provided with apparatus for accurate measurements of speed, load, air consumption, fuel consumption, etc.

The effects on volumetric efficiency of variations in revolutions per minute, inlet pressure, exhaust pressure, inlet temperature, and jacket temperature were determined over a wide range.

Results of these tests are given in the form of curves of volumetric efficiency plotted against the nondimensional ratio s/c, where s is the average piston speed and c is the speed of sound in the inlet air. A mathematical correlation of the results is offered together with possible explanations of the trends observed.

Curves are also included, showing the difference in volumetric efficiency between normal running and "motoring" the engine at various speeds.

The experimental work on which this paper is based was conducted at the Sloan Laboratories for Automotive and Aircraft Engines of the Massachusetts Institute of Technology.[1]

Presented at the Power Plants and Propellers Session, Eleventh Annual Meeting, I.A.S., New York, January 25–29, 1943.

* Formerly Research Assistant, Sloan Automotive Laboratories, now Flying Cadet, U.S. Navy Air Force.

† Professor of Automotive Engineering.

THEORETIC CONSIDERATIONS

THE MAXIMUM INDICATED OUTPUT of a four-stroke internal combustion engine is limited by its air capacity and efficiency. This may be stated mathematically by means of the relation:

$$JP_{max.} = MFE_c\eta$$

where

- $P_{max.}$ = maximum indicated power output
- J = mechanical equivalent of heat
- M = weight of air supplied to engine per unit time
- F = fuel-air ratio for maximum power
- E_c = heat of combustion of fuel used
- η = indicated thermal efficiency at maximum power conditions

In the case of internal combustion engines, maximum values of F, E_c, and η are imposed by the character of the fuel to be used and by various other practical considerations. The only unlimited variable at the designer's disposal, therefore, is the air capacity. A convenient expression involving air capacity is as follows:

$$M = nV\rho_i e$$

where

- n = number of suction strokes per unit time
- V = piston displacement of one cylinder
- ρ_i = inlet density
- e = a dimensionless quantity called the volumetric efficiency, defined by the above equation

If it is desired to make e representative of cylinder-and-valve performance, independent of pressure loss in the carburetor and air intake system, it is necessary to measure inlet density in the intake manifold. Manifold pressure can be measured with reasonable accuracy in a multicylinder engine such as the one used here. However, it is impractical to measure temperature in the inlet manifold of a carburetor engine because of the error introduced by the presence of liquid fuel. To avoid this difficulty in the work reported herewith, the density ρ_i was computed at manifold pressure, but at the temperature of the air entering the carburetor. For comparative purposes at least, this compromise should be entirely satisfactory.

C. Fayette Taylor.

Operating Variables

It is common experience, and also can be shown theoretically,[2] that operating conditions have a profound effect on volumetric efficiency. The object of this investigation was to determine the effect of the more important operating variables for the case of one engine and to develop methods of correlating the results with each other and with theory as far as possible.

The volumetric efficiency, as herewith defined, is usually less than unity because of: (1) fluid friction in the inlet system; (2) heat transferred to the charge from the inlet valve, manifold, and cylinder walls; and (3) the expansion of residual gases if exhaust-pipe pressure is higher than inlet manifold pressure.[2] Inertia of the gases in the manifolds may tend to increase or decrease volumetric efficiency depending on the speed of the engine and the design of the inlet system.[3]

For a given engine the most important independent variables affecting volumetric efficiency can be listed as follows: P_i, inlet pressure; P_e, exhaust pressure; T_i, inlet temperature; T_j, jacket or cylinder-wall temperature; r.p.m., the revolutions per minute of the crankshaft; and F, fuel-air ratio.

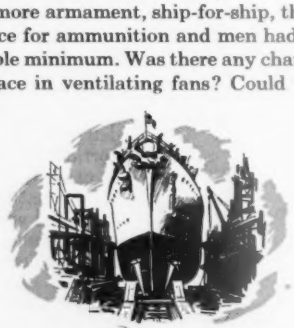
The Story of a SECRET AIR WE

...Now on The U.S.S. Helena 40 Fathoms Down—In Kula Gulf!

PERHAPS YOU'VE HAD WIND of this story already. It's being talked about in engineering circles, among production men, even executives. Make no mistake — when a development comes along, so different that the U. S. Navy takes it over — lock, stock and barrel, that's big news — and has implications for all business and industry.

For its beginning let's go back to before Pearl Harbor. America's fighting fleet was being designed along lines that packed more power and more armament, ship-for-ship, than anything else afloat. Space for ammunition and men had to be shrunk to the irreducible minimum. Was there any chance of saving weight and space in ventilating fans? Could the

1940—MORE SPEED AND ARMOR MEANS LESS SPACE FOR AUXILIARIES

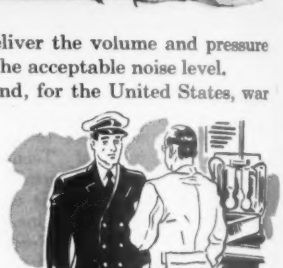


compactness of an axial flow fan be combined with the performance of a centrifugal fan? From existing knowledge of fan performance it seemed impossible. But, since one battleship needs as many as 300 separate ventilating systems, an attempt must be made.

Here was a job for the best engineering brains in the country. The U. S. Navy Bureau of Ships wrote the toughest specifications they could devise — and then subsidized two separate research authorities to develop a fan to meet them. One was the country's outstanding industrial research laboratory — the other, one of the nation's foremost experts on aerodynamics. The results turned in were good, but not good enough. The fans did not deliver the volume and pressure required — and were above the acceptable noise level.

Time was slipping away and, for the United States, war

1941—THE NAVY ASKS THE IMPOSSIBLE— FINDS IT READY AND WAITING

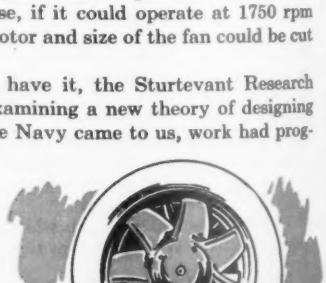


was just over the horizon. Then the Navy came to Sturtevant and put the job up to us.

Here were the requirements — a fan to deliver 12,000 cubic feet a minute (50% more than they had been working toward before) at 3″ pressure and a speed of 1160 rpm. It would be ideal, of course, if it could operate at 1750 rpm because weight of the motor and size of the fan could be cut still further.

Now, as luck would have it, the Sturtevant Research Laboratory had been examining a new theory of designing propeller fans. When the Navy came to us, work had prog-

THE FAN THAT CAUSED ALL THE SHOUTING ABOUT AXIAL FLOW

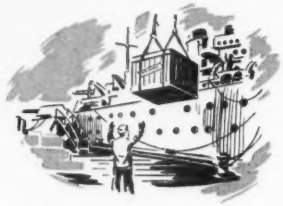


STURTEVANT — ORIGINATOR OF THE NAVY'S

WEAPON

ressed to the point where construction of a test fan had just been completed. Although no experimental work had been done on the fan, we brought it out for inspection. At first glance it appeared to be exactly the fan the Navy men had dreamed of. On the test block it delivered 12,000 cfm at 3″ pressure — on the nose! And at 1750 rpm it showed a sound energy that was 40% under the Navy maximum! Performance astounded them — total efficiency 90%; static efficiency over 80% — better than anything ever achieved with centrifugal fans.

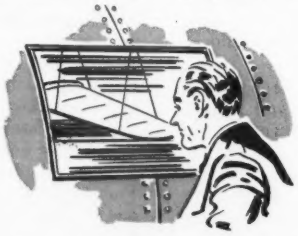
SENT TO SEA WHEN ONLY FOUR WEEKS OLD



Next came a trial run at sea. Less than four weeks after the test fan had been built, it was aboard the U. S. S. HELENA. Line officers were as enthusiastic about the lack of noise as the engineers had been about its performance. Success of the Sturtevant Victory Axiflo Fan, as it is now called, was written in the initial order for 280 units. Today, that original Axiflo Fan — the first, hand-built unit to embody this great step forward in air engineering, shares with the HELENA its hallowed grave in the waters of Kula Gulf.

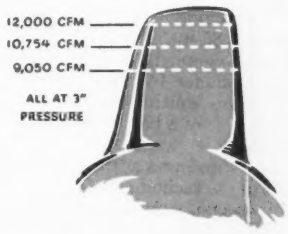
But let's return to the laboratory, for a minute with Harold F. Hagen, our Chief of Research. Here was a development that went right from the sketch pad, into the drawing room and the shop *without experimental development* — and then into large-scale production. How was this possible? Principally because it had been completely proved in theory, before any experiments were made. The new theory conceived by Mr. Hagen was based on the tests of airfoils in a wind tunnel. In putting this theory through its paces, however, he found that these tests could not be applied directly to a fan propeller. In the case of a plane, the air stream is changed only slightly whereas with a fan it is definitely curved. So he dropped the straight line of the airplane flow and substituted the curved line to get proper action of the fan blade — and then applied the airplane theory to that curved line.

THE AIRFOIL TESTS APPLIED TO A PROPELLER FAN



As the design progressed, the blade angles and area of blade surface proved to be just about equal to empirical designs. The result was a blade that does an equal amount of work throughout its entire surface — whether at the hub, the middle or the tip. Air delivery of a specific fan, for example, with blade lengths varied all the way from 46″ to 26″ was always at 3″ pressure — with a volume proportional to the length of the blades. Among the orders for the first 1,500 Axiflo Fans, there were 66 different sizes. These were completely covered with 8 standard fans — simply by changing the blade lengths.

THE RESULT OF A COMPLETELY THEORETICAL DESIGN



With the outbreak of war, Navy demands for Victory Axiflo Fans skyrocketed. Today, thousands of Sturtevant Victory Axiflo Fans are in service aboard battleships, cruisers, aircraft carriers, destroyers, subchasers — in fact, every type of naval vessel. But even Sturtevant's great shops were unable to fill the demand. Other manufacturers were impressed by the extraordinary success of the new type of fan and followed Sturtevant's lead. Two were successful, and are now supplying excellent fans of their own.

The Victory Axiflo Fan belongs to all America. It belongs to the men of the Navy who serve with it now and to the men of industry who are waiting to use it after Victory — to open new fields of heating, ventilating, air conditioning, mechanical draft and other applications where fans are used.

B. F. STURTEVANT COMPANY
Hyde Park Boston 36, Mass.

THE ANSWER TO YOUR WHYS AND HOWS— FREE ON REQUEST ➡

Glance over the brief advantages below and then turn your imagination loose on the implications of the Sturtevant Victory Axiflo Fan *in your work* after the war.

POWER SAVINGS — extremely high fan efficiencies — making important operating economies in large installations.

SPACE SAVING—only 60% of that required for other fan designs—with a similar saving in weight.

FLAT HORSEPOWER CHARACTERISTIC—effecting worthwhile power savings wherever fans are operated at varying loads.

EXTREME QUIET—less than 80 decibels, making it suitable for commercial heating, ventilating and air conditioning installations.

HIGH SPEEDS—permitting the use of standard high speed motors—saving both in weight and initial cost.

RANGE OF PRESSURES—from ½″ to 60″ water gauge—covering the entire field of commercial and industrial fan requirements.

Sturtevant

REG. U. S. PAT. OFF.

Puts Air to Work

VICTORY AXIFLO FAN

The work herewith reported covers some effects of the first five variables over most of their useful range for one particular engine. The effect of fuel-air ratio was not investigated, but, within the useful range, it is known to be small.[2]

Apparatus and Procedure

The engine used in this investigation was an 85-hp. Ford V-8, 1940 model. It was coupled to a Sprague electric dynamometer by which the speed and load were controlled. The torque was measured by a beam scale on the dynamometer.

The speed was adjusted by combined use of a tachometer and a 60-cycle stroboscope. A small disc in the coupling was marked with lines spaced so that they appeared stationary at each even hundred r.p.m. under the stroboscope.

The air was brought into the engine through a 50-gal. steel barrel and measured by a calibrated orifice at the entrance to the barrel. The pressure drop across the orifice was measured by an inclined alcohol manometer. The inlet air temperature was controlled by electric heating coils in the pipe between barrel and engine.

Fuel Measurements

The fuel was measured by means of a rotameter that was calibrated before any tests were made. A stop watch and burette were used as a check and were also used at high speeds where the rotameter was inaccurate due to vibration or where the readings were off scale. A back-suction control was used on the carburetor to control the fuel-air ratio. Connections by tubes were made from the top of the float chamber to points above and below the venturi. The rate of fuel flow could be increased or decreased by increasing or decreasing the pressure in the float chamber by means of control valves in these tubes.

Temperature Control

The cooling system was connected to the city water supply and the water was circulated through an external loop of pipe by the water pumps on the engine. Jacket water temperature was controlled by varying the amount of water supplied from the outside. Each bank of four cyclinders was cooled separately.

Glass thermometers were used to indicate the temperature of the cooling water leaving each jacket, the oil temperature, the inlet air temperature, and the temperature of air just before the orifice in the air barrel. Inlet air temperature was measured in the inlet pipe just ahead of the carburetor.

Inlet and Exhaust Pressures

The exhaust manifold was connected to an exhaust pump which permitted exhaust pressures below atmospheric. For pressures above atmospheric a throttle valve in the exhaust pipe was used.

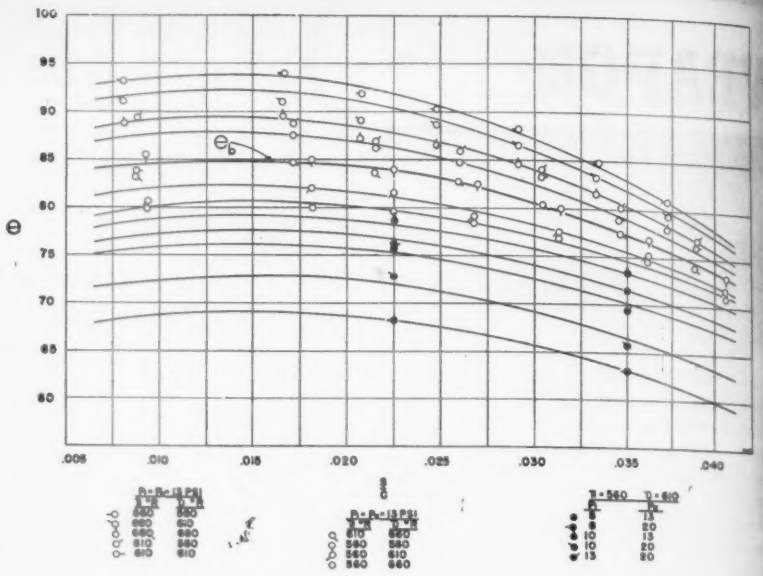


Fig. 1. Effect of s/c on volumetric efficiency at various values of T_i, T_j, and P_e/P_i. Curve marked e_b is plotted from the relation $e_b = f_1 = 0.818 + 4.3(s/c) - 160(s/c)^2$.

Both inlet and exhaust pressures were measured by mercury manometers, the connection to the inlet being directly to the inlet manifold, while the exhaust connection was in the exhaust pipe several feet below the manifold. The exhaust gases were cooled by a spray of water injected directly into the exhaust pipe.

In addition to the standard Ford oil pump, an external pump was used to maintain the desired pressure in the system. This pressure could be controlled by external valves and was indicated by a gauge on the control panel.

Oil Temperature

The oil temperature was controlled by a heat exchanger in the external system in which both water for cooling and steam for heating the oil could be used.

On all runs the oil temperature was kept at 180°F., and spark and fuel-air ratio were set for best power. After each setting the engine was allowed to run until a steady state was reached so that readings would be consistent. Since the air measurements were of primary interest, care was taken to make them as accurate as possible. The manometer was read only when speed was exactly correct, and the temperature of inlet air was read at the same time.

Runs were made over a speed range between 1,000 and 4,500 r.p.m. with various combinations of inlet air temperature, T_i; jacket-water outlet temperature, T_j; inlet pressure, P_i; and exhaust pressure, P_e. To study the effect of motoring on air capacity, motoring runs were made from 2,000 to 4,500 r.p.m., with $P_i = P_e = 13$ lbs. per sq.in., $T_i = 100$°F., and $T_j = 150$°F.

Results of the tests under normal operation are given in Fig. 1. Fig. 6 shows the results of the motoring tests.

Discussion and Correlation

In any problem involving high-speed flow of gases, the Mach number, or ratio of gas velocity to sound velocity in the gas, is of primary importance. Since in an engine the velocity of gases in the inlet system varies periodically in a complex manner,[3] the actual gas velocity is both difficult to measure and to define. However, the velocity in the inlet system is a function of piston velocity, which can easily be evaluated.

If it is assumed that the average velocity in the inlet system is proportional to the average velocity of the pistons and that the speeds of sound throughout the inlet system are proportional to the speed of sound in the inlet air, the ratio s/c, where s is the average piston velocity and c is the velocity of sound in the inlet air, can be used in place of the Mach number. For this reason volumetric efficiency has been plotted against s/c in Fig. 1.

The fact that the curves for various combinations of inlet temperature and jacket temperature are similar to each other on this basis seems good indication that the use of s/c in this manner is justified.

The faired curve of Fig. 1 passing through or near the points where $T_i = T_j = 560$°R and $P_e = P_i = 13$ lbs. per sq.in. absolute satisfies the following expression:

$$e_b = f_1 = 0.818 + 4.3(s/c) - 160(s/c)^2$$

where e_b is the "base" curve of volumetric efficiency.

Speeding
the Timetables of INVASION
Months ago a new and revolutionary tool of war . . . a giant troop and cargo transport named the Curtiss Commando . . . began to accelerate the timetables of invasion.
Today these great ships are swiftly spanning oceans and continents, transporting ever-increasing numbers of men, ever-mounting tons of supplies, to the theaters of action.
Commando performance in this new phase of military aviation has proved so effective that the U.S. Army has called upon Curtiss-Wright to devote facilities in four of its huge plants for the production of unprecedented numbers of these war giants . . . the world's largest twin-engined transports.
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See why we build 'em fast?

At all these major bases and active fronts, U. S. Army Bell Airacobras are in the air day after day and week after week

More are being readied for action in secret sectors that will explode into fighting fronts as our offensive plunges ahead.

A good fighter plane is basic in modern strategy. The Airacobra is a tough, fast, versatile, single engine ship armed with heavy machine guns and a cannon. No battlefront ever has too many good fighter planes like the Airacobra.

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See why we must build 'em fast?

MASS PRODUCTION TECHNIQUES, developed to meet the demands of war, will be ready and waiting to build the planes of peace. That's one reason why your postwar aircraft will be far better, far lower priced than the types you knew before the war. © Bell Aircraft Corporation, Buffalo and Niagara Falls, New York.

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AIRACOBRAS for victory—future planes for peace

BUY WAR BONDS AND SPEED VICTORY

HOME *Straight as an Arrow...*

With the unconditional surrender of our enemies,—which must be won by our blood, sweat and toil—, will come peace and the post-war period of reconstruction and development.

Aviation, now the No. 1 industry of America, will continue to lead the way. From the centers of our great cities to the vast expanses of our rural sections, Airplanes will play a leading part in our lives. Distances between home and place of business will be of much less importance, as the speed and efficiency of Aircraft will make commuting practical and economical. You can go home straight as an arrow, from wherever you are.

Advanced engineering and foresight will continue Jacobs leadership in the production of dependable and economical Aircraft Engines —*practical engines* for the private owner, the business concern and the "feeder" Airline.

JACOBS AIRCRAFT *Engines*

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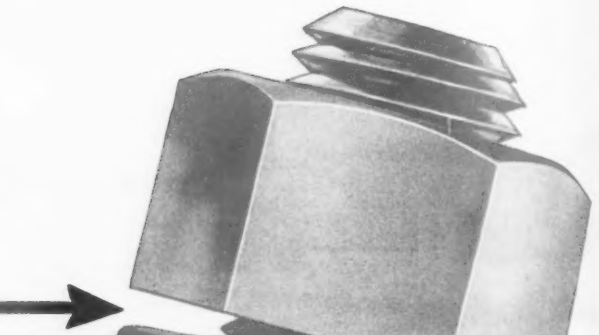
A little spring can't go a long way

So when you order spring washers specify the ones with long range of spring power



INSIST ON KANTLINKS—the big long-range spring washers that expand and compensate for inevitable wear of bolted parts.... There is no substitute as economical on any assembly that is subjected to vibration. Short-range multi-toothed washers that bite in can not give you the wide expansion range of Kantlinks' **spring power.**

Furthermore, Kantlinks should be used with **every** type of nut, whether a regular standard nut or any one of the many fixed or locked nuts. For even if the nut never budges on the bolt, all other parts of almost every bolted assembly loosen sooner or later unless an adequate size helical **spring** washer is used to hold every part tight.

The parts will loosen because of bolt stretch, and frictional wear of metal on metal, burrs and flares, and because of pulverizing of paint, scale, and rust.

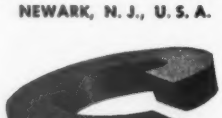
This is war time—be safer with powerful Kantlinks.

Let us send you samples—send details of your application. Test and compare them on the same job with any type of nut, or with any other type of washer. Kantlinks can't lose a real test. Try them for efficiency, economy and real safety.

Write today for descriptive folder.

THE NATIONAL LOCK WASHER COMPANY
NEWARK, N. J., U. S. A.

KANTLINK TRADE MARK



the long-range Spring Washer

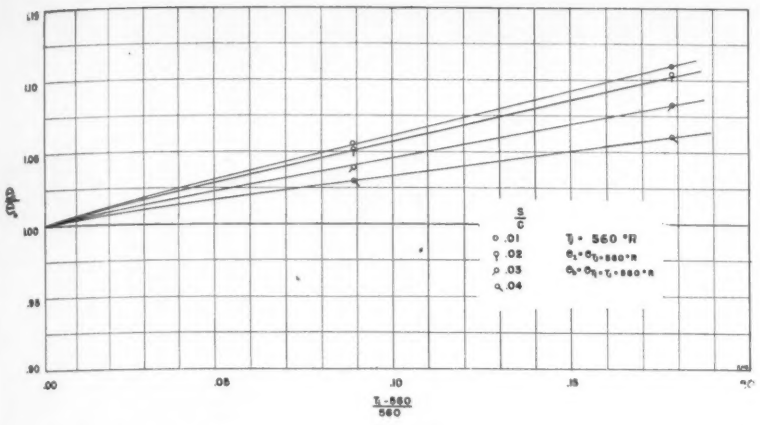


FIG. 2. Effect of T_i on the ratio e_1/e_b when $T_j = 560R$. Straight lines are plotted to the relation $e_1/e_b = f_2 = 1 + [(T_i - 560)/560][0.635 - 186(s/c)^2]$.

The effects of variations of T_i and T_j on e at various values of s/c are given by Figs. 2 and 3. Because of the fact that e is dimensionless, one is tempted to plot e as a function of the dimensionless ratio T_i/T_j. Inspection of Figs. 2 and 3 shows this to be futile, however, since the influence of T_j on e is considerably less than that of T_i. The explanation of the smaller influence of T_j probably lies in the fact that the engine temperatures that are effective in controlling the heat transfer to the incoming charge do not vary with T_j alone but are subject to other influences, such as the combustion temperatures

If we let the engine temperature effective in controlling the heat transfer to the inlet charge be T_m, the heat transferred to the charge during induction would be equal to $K(T_m - T_i)$ where K is a coefficient depending on the design of the inlet system, the gas velocity through the system, and the density and viscosity of the gases. The ratio of volumetric efficiencies at two different values of T_i would then be expressed:

$$\frac{e_2}{e_1} = \left[\frac{(T_i)_2}{(T_i)_1}\right]\left[\frac{(T_i)_1 + K(T_m - T_i)_1}{(T_i)_2 + K(T_m - T_i)_2}\right]$$

Endeavors to evaluate K or T_m on the basis of the data obtained from these tests have so far not met with success, and a straight mathematical correlation is therefore presented.

Figs. 2 and 3 show that at a given value of s/c the effects of T_i and T_j on e are substantially linear. The slopes of the lines, however, are functions of s/c. From Fig. 2 it was found that the effect of T_i on e_1 when $T_j = 560°R$ could be expressed with satisfactory accuracy by the following:

$$\frac{e_1}{e_b} = f_2 = 1 + \left\{\left(\frac{T_i - 560}{560}\right) \times \left[0.635 - 186\left(\frac{s}{c}\right)^2\right]\right\}$$

where e_1 is the volumetric efficiency when $T_j = 560°R$.

Fig. 3 shows the effect of T_j on e/e_1. From this plot the effect of T_j is found to be very nearly according to the following:

$$\frac{e}{e_1} = f_3 = 1 - \left\{\left(\frac{T_j - 560}{560}\right) \times \left[0.299 - 87.5\left(\frac{s}{c}\right)^2\right]\right\}$$

From these relations, e for any combination of T_i and T_j within the limits of the test can be predicted with a fair degree of accuracy, since

$$e/e_b = (e_1/e_b)(e/e_1)$$

Considering the functions f_2 and f_3 in the light of the heat transfer expression, a qualitative agreement with theory is evident. An increase in T_i should improve volumetric efficiency, since the inlet density varies inversely as T_i while the heat transferred to the air during its passage over the hot surfaces of the inlet system is decreased because of the reduced temperature difference between air and surfaces. Fig. 2 shows this to be the case. The effect of T_i on volumetric efficiency should be less as s/c increases, because the heat transferred per unit weight of gas passing through the inlet system goes down as the velocity goes up. It is well established that at a given temperature difference heat transferred from a surface to a gas varies as the mass flow to a power appreciably less than unity. This tendency is also evident in Fig. 2 and in f_2.

The effect of T_j on e, as shown by Fig. 3 and f_3, is also in qualitative accord with theory. The higher the jacket temperature, the more heat is transferred to the inlet charge and the greater is the reduction in the charge density arriving in the cylinder. Thus, e should fall off with increasing T_j, and this is

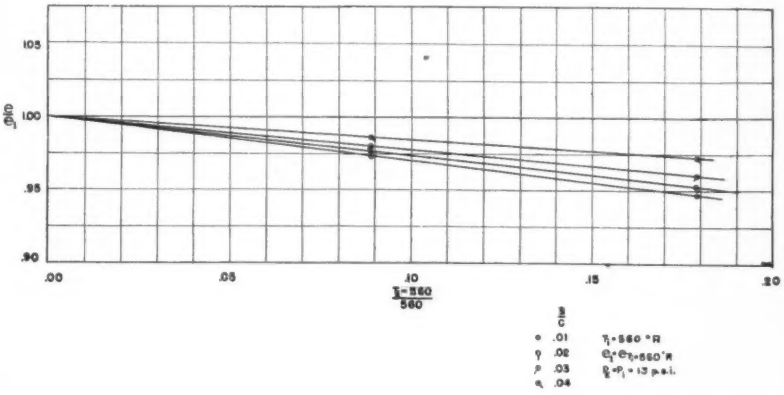


FIG. 3. Effect of T_j on the ratio e/e_1. Straight lines are plotted to the relation $e/e_1 = f_3 = 1 - [(T_j - 560)/560][0.299 - 87.5(s/c)^2]$.

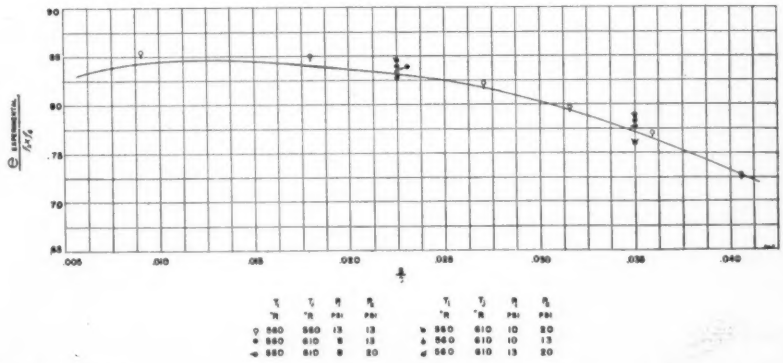
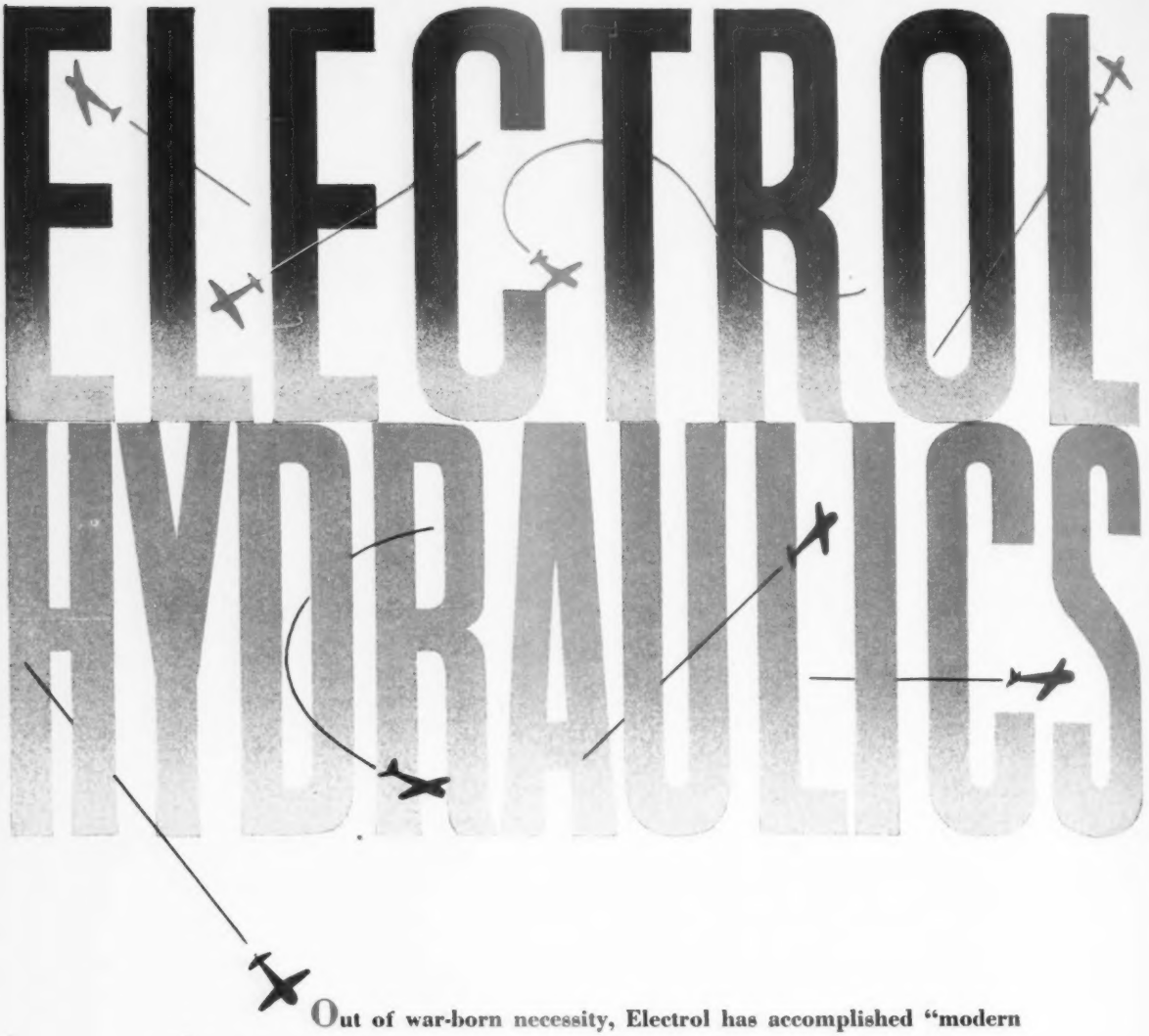


FIG. 4. Effect of P_s/P_i on volumetric efficiency. Points are plotted to the relation $(e/f_3 \times f_4)$ where $e/e_b = f_4 = [6.3 - (P_s/P_i)^{0.715}]/5.3$.

ELECTROL HYDRAULICS



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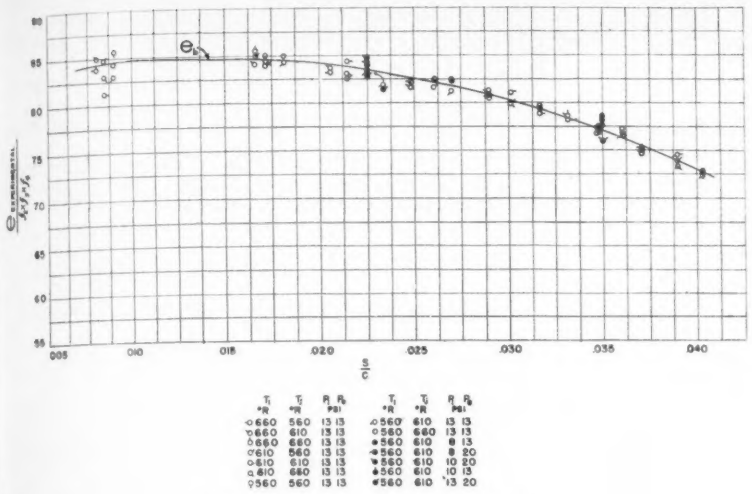

FIG. 5. Correlation of results of all tests.

apparent in both Fig. 3 and f_3. The effect of T_j should become less as s/c increases because heat transfer to a moving stream of gas varies as the mass flow to a power less than unity. This trend is also apparent in the curves and equation.

Fig. 4 shows a correlation of the effect of the ratio of exhaust to inlet pressure on volumetric efficiency. If it is assumed that at the end of the exhaust stroke the combustion space is filled with residual gases at P_e and that when the inlet valve opens these gases come into pressure equilibrium with the inlet gases, it can be shown[2] that

$$\frac{e_2}{e_1} = \frac{r - (P_e/P_i)_2^{1/k}}{r - (P_e/P_i)_1^{1/k}}$$

where r is the compression ratio, k is the ratio of specific heats, and the subscripts refer to two different ratios of P_e/P_i.

Since the compression ratio of the engine used was 6.3 and since $k = 1.4$, the ratio of e to e_b is as follows:

$$\frac{e}{e_b} = f_4 = \frac{6.3 - (P_e/P_i)^{0.715}}{5.3}$$

Fig. 4 is a plot of values of e determined by test divided by the product $(f_1 \times f_3)$, compared with the e_b curve. It was necessary to introduce f_3 in this case to correct for the fact that the tests with various values of P_e and P_i were made with a jacket temperature of 610°R while the base curve is taken at $T_j = 560°R$. The degree of correlation is indicated by the approach of the points to the curve.

The complete expression that has been developed for e as a function of s/c, P_e/P_i, T_i and T_j is as follows:

$$e = \left[f_1\left(\frac{s}{c}\right)\right]\left[f_2\left(T_i, \frac{s}{c}\right)\right] \times \left[f_3\left(T_j, \frac{s}{c}\right)\right]\left[f_4\left(\frac{P_e}{P_i}, r\right)\right]$$

where

$$f_1 = 0.818 + 4.3\left(\frac{s}{c}\right) - 160\left(\frac{s}{c}\right)^2$$

$$f_2 = 1 + \left\{\left(\frac{T_i - 560}{560}\right) \times \left[0.635 - 186\left(\frac{s}{c}\right)^2\right]\right\}$$

$$f_3 = 1 - \left\{\left(\frac{T_j - 560}{560}\right) \times \left[0.299 - 87.5\left(\frac{s}{c}\right)^2\right]\right\}$$

$$f_4 = \frac{6.3 - (P_e/P_i)^{0.715}}{5.3}$$

The overall correlation is shown by Fig. 5, which shows the test values of e divided by the product $f_2 \times f_3 \times f_4$ plotted against s/c and compared with $e_b = f_1$.

It would be of interest to investigate the effects of the same operating variables in the case of other engine designs, particularly aircraft engines where knowledge of the factors influencing volumetric efficiency might lead to improved design or performance.

It would also be of interest to make further attempts to correlate these results with heat transfer theory. It is quite possible that with more time at the authors' disposal, a satisfactory correlation of this kind could have been developed.

Fig. 6 is a comparison of the air capacity of the Ford V-8 engine running normally and being motored with and without fuel. Below $s/c = 0.03$, the fact that motoring air capacity is greater than air capacity firing is probably due to lower engine temperatures during motoring. Above $s/c = 0.03$, this is apparently offset by higher residual-gas pressure in the cylinder when the inlet valve opens. The much greater density of the unburned gases as compared to the burned gases during the exhaust stroke probably accounts for this trend. It is increased still further by the addition of fuel, which lowers the temperature of the gases and increases further their density during the exhaust stroke.

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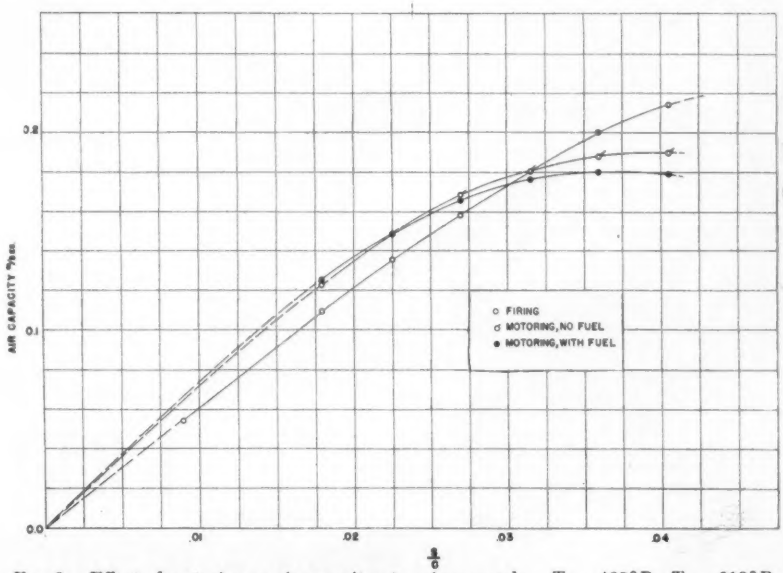

FIG. 6. Effect of motoring on air capacity at various speeds. $T_i = 460°R$; $T_j = 610°R$; $P_e = P_i = 13$ lbs. per sq.in.

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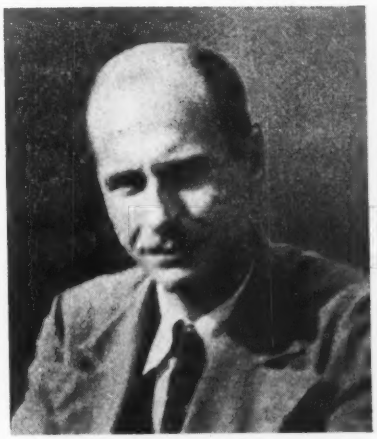

In order properly to evaluate the effects upon operating efficiency of various actions it becomes necessary at the start to agree upon some sort of measure or yardstick that can be used as a basis for comparing results. For this reason efforts will first be directed toward the development of a formula for the measurement of operating efficiency.

It must be recognized that there are various types of long-range operations. They are not subject to direct comparison between themselves because it frequently happens that a relatively inefficient type of operation must be condoned if a certain type of mission is to be accomplished. We must therefore break down our long-range operations as to types and develop for each type a formula for the measure of operating efficiency.

Operations will generally be found to partake of the characteristics of either or both of two basic types—an operation for the maintenance of a service and an operation for the bulk carriage of passengers and goods between two distant distributing centers. These operations have used two basically different methods for their accomplishment—an operation over developed airways and an operation over undeveloped or even nonexistent routes. These two basic types and two basic methods of operation will be briefly discussed.

The Maintenance of a Service

This type of operation represents the usual role of the common carrier. From the point of view of the public, first importance is placed upon the maintenance of a service over a given route. Second place is given to frequency of service, and volume of traffic rates third. From the point of view of the operator the degree of emphasis placed upon each of these three elements will vary. In its lowest form this type of operation is represented by a route that is maintained merely to hold a desirable but nonprofitable franchise and will therefore emphasize the first element. Schedule frequency will be the lowest permissible under the terms of the franchise. Volume of traffic may be almost nonexistent in an operation that is conducted at a loss. In a higher form of this same general type of operation a greatly increased emphasis on load is found, which in time will call for an increase in schedule frequency. During wartime it might be felt that schedule frequency should be subordinated to load and that ships should be held until fullest or most valuable loads can be developed. This is not actually the case because the main value of this type of operation lies in its ability to transport passengers, mails, and goods in a minimum of time from point of origin to destination. If this week a ship is held in the hopes of filling it with a load of priority officers instead of the available load of nonpriority privates, this same ship, because of the delay, will not be back in time for its next schedule which must now be delayed as well. Thus the main value of the service is lost.

So in peacetime or in war the main elements entering into this type of a service in order of their importance are: (1) maintenance of a route, (2) frequency of service, and (3) load capacity.

The Bulk Carriage of Passengers and Goods between Two Distant Distributing Centers

It is apparent that in this type of operation load capacity is the prime factor, with the elements of frequency of service and maintenance of the route subsidiary by-products. There will be times when in order to attract business frequency of schedule becomes of increased importance. At other times the volume of business increases to the point of embarrassment, an increase in schedule frequency may be called upon in order to provide increased capacity. In either case, frequency of schedule is subsidiary to the main object of the operation, which is the carriage of maximum pay load between two distant points.

A Maximum Tonnage Type of Operation

The above type of operation is basically the simpler of the two. It consists merely in the carriage of goods without reference to the method, route, or degree of speed. A formula for calculating the efficiency of the operation of this type of route must therefore contain an element representative of volume of goods. "Tons" will suffice for this. Distance must be included so that various routes of the same type but of different length may be compared. "Miles" is the natural measure of this element. Variations in the number of planes used for a particular service will have an effect upon certain aspects of operating efficiency. For example, an increase in the number of ships using a route will have the tendency to increase efficiency through the reduction of various fixed charges and overhead expenses. At the moment, however, we are considering efficiency only as it relates to the usage of individual units of the fleet. A "per ship" item should therefore be included in the formula. Finally, the element of time must be introduced so as to give a measure of the rate of doing work. The formula then is simply:

$$\frac{\text{tons} \times \text{miles}}{\text{number of ships} \times \text{number of days}} = \text{measure of rate of flow of goods}$$

For the purposes of this paper the figure "hours per day per ship" will be as accurate as "miles per day per ship" and much more easily handled. The formula then becomes "ton-hours per day per ship." It will be noted that no element of cost is included. In a peacetime commercial enterprise this omission would prove fatal. But it must be remembered that the economics of war is primarily an economics of time and not of dollars. In this operation the aim is to move the most goods in the fewest days rather than the most goods for the fewest dollars. With this point in mind look once more at the formula. It will be noted that hours per day per ship carries equal value with the figure for tonnage. Doubling one is as productive as doubling the other. This is a point that is frequently overlooked. Sometimes in an effort to increase tonnage the schedule is slowed down to a point where the tons moved per day actually shows a decrease. Here is an actual example:

Two different schedules using identical equipment were flown over the same 4,000-mile route. In the first schedule an effort had been made to develop

Presented at the Air Transport Session, Eleventh Annual Meeting, I.A.S., New York, January 25–29, 1943.

* Captain.

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maximum tonnage. In the second schedule everything had been subordinated to speed with no pretense of developing the load factor. Yet this second schedule moved 33½ per cent more tonnage than the first. As mentioned above this paper will not attempt to cover the field of cost of operations. But it must be observed that this second, faster, and more productive schedule was not necessarily the more expensive of the two. True, the operating expenses per ton-mile were higher, but the cost of operating and maintaining airports was lower because of the elimination of one stop, and the fixed charges were less because the schedule was nearly twice as fast.

A Maintenance-of-a-Route Type of Operation

It will be remembered that the first of the two types of operations outlined stressed the maintenance of the route and the frequency of service, with the element of load capacity coming in a poor third. In an operation of this sort the gross tonnage moved during a month is not the vital figure. In its lowest form it need merely be said of this operation that during the month a certain number of ships were flown over the route. There seems to be little justification for this type of operation for the duration of the war. However, it is frequently vital to provide a service of which it can be said that at any time during the month it was possible for a staff officer, diplomat, or courier to decide to leave and within a certain number of days to arrive in London, Moscow, Darwin, Cairo, Washington, or Chengtu.

In setting up this operation the desired scheduled frequency will first be determined. From this it should be possible to calculate the cabin load that will be required of each ship. This figure will be set up as a constant. It will therefore not enter into the formula for evaluating the effect of variables upon operating efficiency. The efficiency of this type of operation, then, is measured simply by the hours per day per ship developed on the route.

There are now two basic types of operations to consider, as well as a measure for each: a bulk carrier type of operation whose efficiency is measured by the formula ton-hours per day per ship, and a maintenance-of-a-route type of service measured by hours per day per ship. In the first, tonnage will be balanced against hours per day. In the second, hours per day will be the main consideration.

Developed and Undeveloped Airways

Prior to Pearl Harbor the development of an airway, particularly in long-range operations, was a lengthy and detailed procedure. The transpacific airway was typical of this meticulous method. Years of research, training, and development preceded the flight of the first ship over this route; one year of flight operations preceded the carriage of a single passenger. Not till then was this considered a developed airway and available for full commercial use. Long-range flights off the airways, such as those of Hughes and Archibald, were made during this period but not in transport service.

It was after Pearl Harbor and under stress of war that Captain Ford and his crew brought a clipper from Auckland westward to New York, more than two-thirds of the way around the globe and much of the way over uncharted airways. This flight highlighted the potentialities of these ships and crews that had developed a high degree of self-sufficiency. In the months that followed many similar trips were made. Ships departed with stores of spare parts and food, manned by self-sufficient crews, to return weeks later after ranging much of the earth's surface. Regardless of where they went they were thankful for what they got but demanded no more than fuel. Whether completion of a mission called for the forging of a special tool at the blacksmith's or building an oven and baking their own bread on a coral beach, these crews were on their own. The exigencies of war called for a service *now*, to be followed by the development of further airways later when time permitted.

The existence of this fleet of long-range ships, of flight crews and ground forces trained to self-sufficiency, of adequate main bases, and the use of basic world routes all made possible the kind of irregular, charter-like type of operation called for during those first months of United States' participation in the war. It was apparent from the start that a high degree of efficiency would not be obtained from this kind of operation. Under these difficult circumstances a transport service of any kind was a modern miracle. Yet it was felt that the operations would stabilize into a basic pattern; so an early analysis was made of the problem in an effort to outline a method for increasing efficiency as fast as the opportunities arose. The results of this program have been gratifying, though needless to say the effort to develop further efficiency goes on.

A method of analysis and attack similar to that used in developing the operations mentioned above follows. The period of operation over undeveloped routes provided much of the data.

In the development period during a slightly better than average month, a typical ship spent its time as follows: nine days of flight time on scheduled routes, nine days at the main overhaul base undergoing overhaul and providing training time, and twelve days at anchor in foreign ports. In spite of the excellent work being done in producing quick maintenance "turnarounds," it was possible that the time required for main base overhauls could have been further reduced. That is outside the province of this discussion. The problem was the reduction of the time spent at anchor abroad. Scheduled stops and layovers are for the following reasons: (a) to work cargo and fuel the ship, (b) to service the ship, (c) to rest the crew (in the case of continuous crews), (d) because of harbor restrictions, and (e) because of bad weather.

In discussing the above elements their effect upon ton-hours per day, as well as upon hours per day, will be evaluated so as to provide criteria for both types of operation under consideration—that is, for the maintenance of a service type of operation and for a bulk carrier type of operation.

Stops for Cargo and Fuel

Consider that the ship is to remain away from the main overhaul base for 200 hours. Assume that it will fly straight out for 100 hours and then straight back. The trip will be broken as often as is desirable from the point of view both of maximum ton-hours per day and of maximum hours per day. Each transit stop will be charged with a layover time of 2.7 hours. There are two opposing effects in operation here. The further between stops, the higher will be the figure for flight hours per day. On the other hand, the shorter the flights, the heavier will be the loads carried. Fig. 1 is a curve of hours per day plotted against length of flight. It will be noted that for flights of 12 hours or more the curve is fairly flat at a value of about 20 hours a day. Fig. 2 is a plot of cabin load against length of flight. Fig. 3 is a combination of the two previous curves showing ton-hours per day against length of flight. It will be seen that maximum ton-hours per

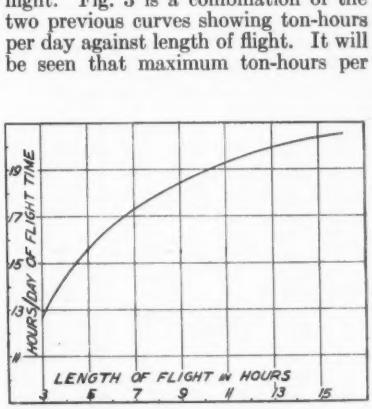

Fig. 1. Limitations imposed upon hours/day by ship—as a function of length of flight.

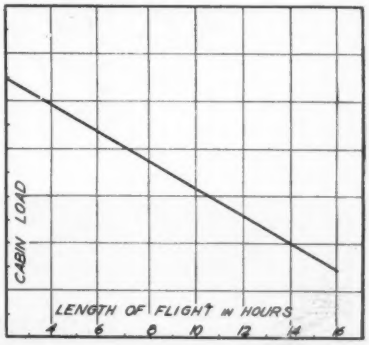

Fig. 2. Cabin load as a function of length of flight.

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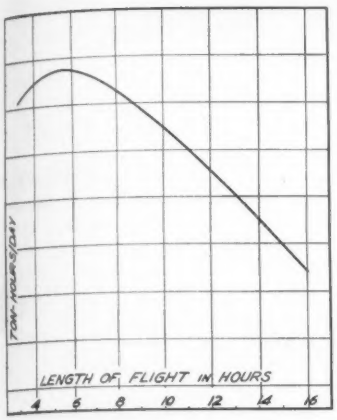


FIG. 3. Limitations imposed upon ton-hours/day by the ship as a function of length of flight.

day is obtained from flights of about 5½ hours' duration. But the load and range capacities of the ship are not the limiting factors in developing either ton-hours per day or hours per day. It will be necessary to look further.

LAYOVERS FOR SERVICING

Servicing the ship on undeveloped routes has been accomplished by the flight engineers by using equipment carried on the ship. This necessitates carrying a third engineer and/or laying over an additional length of time to permit the engineers to rest after completing the servicing. It is a practice that reduced the pay load as well as the hours per day in the air. It is a useful method where a high degree of flexibility in the choice of routes is necessary in order to accomplish a particular mission, but it is no way to develop the maximum efficiency of the ship as a carrier and was one of the first practices altered when routes began to stabilize. On one such flight of 116 hours' air time over an undeveloped route the servicing and attendant rest period alone held the ship on the ground for 41 hours. It has been found that adequate ground crews well equipped can service the ship within the time limits imposed by other considerations. A method of staggered servicing has been used where time is short or crews are small. An example will illustrate the method.

Spark plugs must be changed every 120 hours. The ship will be away from its main base for 200 hours, so one plug change will be called for. This change may occur anywhere between 80 and 120 hours or in all likelihood at any one of four different stations. When crowded for time the plugs of one of the four engines are changed at each of the four stops.

The same technique has been used for oil changes. Because of the high degree of accessibility of the working parts of the ship, much routine inspection can be accomplished in flight.

For these reasons routine servicing has not yet become a critical factor in producing stops and layovers over developed routes.

SIZE OF CREW

A general idea of the size and type of the crew required for long-range operation is necessary before the general subject of crew fatigue can be discussed. Over undeveloped routes crews consisted at times of as many as 14 men. Some of these same routes are now being flown with as few as ten men in the crew. Even though individual flights average 8 hours in length and occasionally exceed 16 hours and even though a crew may be on duty for as many as 48 hours at a stretch, this may still seem like a large crew until the crew duties are analyzed.

Four members of the crew are normally detailed for piloting. Two men could conceivably fly the ship, but, because of greater fatigue, they could not fly it with the same precision as four. A ship of this size climbed carelessly to 8,000 ft. has consumed 74 gal. more of fuel than the same ship climbed with precision. In this instance the precision climb represented a weight saving of more than 400 lbs. of fuel, a weight that in itself easily compensates for the weight of the two extra pilots. But this is far from their total contribution. Two of the four pilots will spend part of their time in maintaining a running set of performance curves familiarly known as "howgozit-curves." These curves eliminate much of the hazard of a faulty forecast and at the same time maintain a definite safety factor. To maintain this same factor of safety without the use of these curves would require the carriage of additional fuel. In South Atlantic operations this would mean a fuel increase and corresponding loss in pay load of more than 1,200 lbs. In North Atlantic operations the penalty might be more than twice as great. Two extra pilots is a small price to pay for so great a return.

One or two members of the crew will be designated navigators. Faulty navigation to the point of missing a destination is a heavy penalty, frequently to be charged to an understaffed navigation department. But it is not so generally realized that there are less dramatic ways in which a navigator earns his place among the crew. Every time his precise navigation shortens the flight by as little as 8 min. he has saved more than his own weight in fuel conserved.

In a round-trip crossing of the South Atlantic the two flight engineers will save several times their weight in fuel by their ability to concentrate all of their energies on the engines. They are now obtaining what is probably the lowest specific fuel consumption in current operations. Of course, their ability to make repairs while the ship is in flight or to spot a small trouble before it becomes a big one has in itself more than justified their inclusion in the crew.

The lower the stage of development of an airway and the less regular the operations over it, the greater will be the dependence upon communications. Locally controlled radio stations have at times proved unreliable or, as in the case of stations on neutral territory, unavailable for the relaying of certain types of messages. The installation on the ships of advanced types of equipment operated by skilled operators has made it possible to maintain communications with the home base even though the ships were at times on the other side of the world and no other form of communications was available. The ship-board radio operators have well earned their places among the crew.

The number of stewards needed depends upon the number of passengers. As long as any passengers at all are aboard it has been found necessary to carry at least one steward in order not only to provide for the comfort of the passengers but also to secure their safety. With the above sketchy description of the flight crews in mind a discussion of the limitations imposed upon hours per day per ship by these crews will follow.

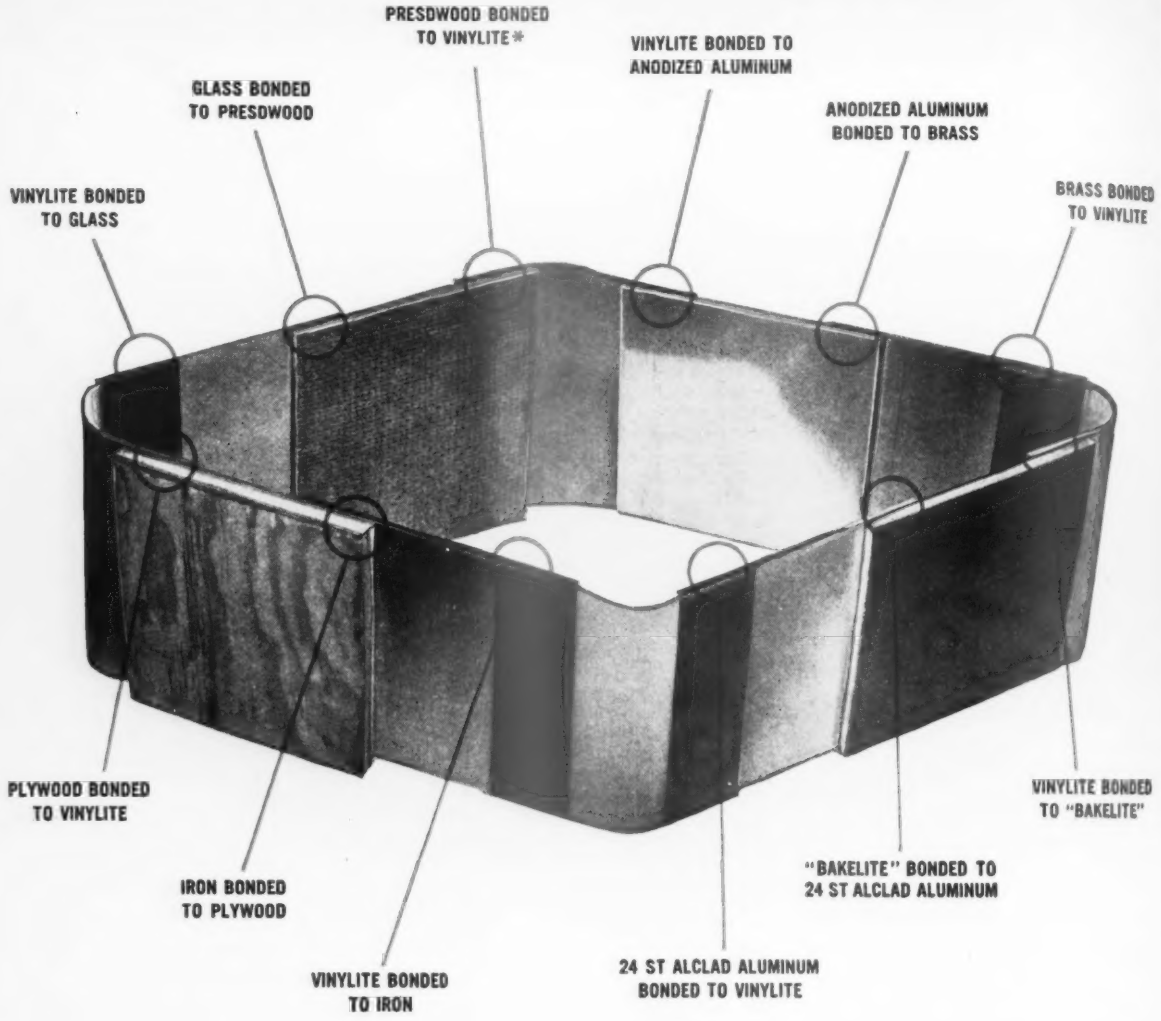
STOPS TO PROVIDE CREW REST

Many people, and with good reason, have felt that the endurance of the crew was the limiting factor in the production of maximum flight hours per day on modern types of long-range equipment. This is sufficiently close to the truth to make the question of serious importance. It is not worth while to improve the ships if the crews that operate them are already outdistanced. The simplest solution to the problem is to change crews as often as a fresh crew is needed. Unfortunately, this is sometimes impossible and seldom desirable. Spotting crews all over the earth's surface like fresh strings of horses on the pony express not only presents a serious morale problem but adds immeasurably to the difficulties of maintaining any sort of training program at the main base. It has the additional drawback of creating a highly inflexible organization. Furthermore, this survey indicates that the point has almost been reached where continuous crews will be desirable from every point of view. At the moment a major bottleneck in plane utility is admittedly the endurance of the crew. Assuming that the number of men composing a crew is fixed, the endurance of this crew is primarily controlled by two factors: amount of sleep per day and working conditions. Much can be done to control both of these.

AMOUNT OF SLEEP

During the first months of the war when ships called wherever they could find fuel and when crews were larger, a a typical watch list showed that each member of the crew was theoretically off watch for from 50 to 67 per cent of any flight.

Records showed that only 21 per cent of gross flight time was being used for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sleep. Of the off-watch time, only 38 per cent was converted into sleep. The record of the conversion of time ashore into useful sleep was no better. A series of observations of twelve officers in five different first-class hotels showed that although the average layover time was more than 15 hours the average sleep was less than 6. The writer has stayed in more than 60 different hostelries as a member of a flight crew. No one of these (that was not designed especially for the purpose) provided proper facilities or service for flight crews. To give a single illustration: An elaborate multicourse dinner served at eight o'clock in the evening is not what a crew needs when it is to be called at three in the morning. Crews operating continuously under those conditions averaged between 4 and 5 hours of sleep out of every 24 for from 7 to 17 days on end. This was little more than half enough. The factors that determine what percentage of flight time will be converted into sleep are as follows: (1) length of flight, (2) recency of an overnight stop ashore, (3) time of day departure is scheduled from a layover port, (4) whether the flight is outbound from port of origin or inbound, and (5) whether the flight is a day flight or night flight. There are in addition certain psychologic factors, difficult to evaluate but none the less important: (1) familiarity with the route (or with special duties), (2) length of service in long-range operations, (3) degree of responsibility aboard, and (4) psychologic make-up of officer.

Length of Flight

The longer the flight, the greater percentage of the time will be converted into sleep. This is primarily because there is a certain amount of overhead work that must be done aboard regardless of the length of the flight. Every officer has special duties to perform in addition to his regular watches. On short flights all of his off-watches will be occupied with these extra duties. A second reason for more sleep per day on long flights is simply that the longer the flights, the less time per day spent in intransit stations where sleep is out of the question. On long flights it is possible to set up off-watches of from 4 to 5 hours. It takes no longer to fall off to sleep for 5 hours than for 5 min.

Recency of an Overnight Stop Ashore

The amount of sleep obtained from the last in a series of flights was 250 per cent greater than the amount obtained in the first in this series. The reason is obvious. On departure from a layover port the crew is called, eats, boards the ship, and takes off. At this point, some 2 hours after tumbling out of bed from a full sleep, one-half the crew is off watch. They cannot sleep and their special duties at this stage of the flight are usually light, so much of the off-watch at this stage in a flight is spent neither in working nor sleeping.

Time of Day Departure Is Scheduled from Layover Port

By the careful selection of the time of departure from a layover port, the amount of sleep obtained on the ensuing flight has been increased 313 per cent over what was obtained from a similar flight less carefully planned. It seems that a late afternoon or twilight departure most readily eases the crew into the routine of sleeping in 4-hour shifts.

Outbound Versus Inbound Flights

The data available indicated that a crew slept 31 per cent better on a return flight than on an outbound flight. This is possibly because the fatigue level necessary for sleep under the unfavorable conditions that prevailed is more quickly reached on a return flight. It might also be because the crew is beginning to accustom itself to sleeping when the opportunity arises rather than just when the sun goes down.

Day Flights Versus Night Flights

Under these methods of operation, other things being equal, a crew obtained 40 per cent of its under-way sleep during the daytime and 60 per cent at night. It seems likely that this was because of the overnight stops along the route. These stops were interjected throughout the trip. They aimed to give the crew 8 hours of night sleep ashore. They were sufficiently closely spaced effectively to prevent a man from falling into the routine of watch and watch sleeping regardless of the time of day. They tended to pull him back to the rhythm with which he is more familiar.

Psychologic Factors Controlling Sleep

This second group of factors is worth some consideration. It is not so subject to control as the first group, but it must receive consideration in any plan that contemplates developing maximum flight hours per day per crew.

Familiarity with the Route

This needs little comment. Statistically, it was found that on his second trip over a route a captain obtained 25 per cent more sleep than on his first trip.

Length of Service in Long-Range Operations

This factor is related to the one above. It is most readily apparent in the inability of the fourth officers as a class to sleep. These men are generally those among the crew with the fewest long trips to their credit. The fourth officers are at or next to the bottom of any crew list in their ability to obtain sleep en route. This is possibly because of the strangeness of this type of flying and because a man has to learn to take advantage of daytime off-watches for sleeping. The fourth officers on two recent trips that the writer commanded obtained less than 10 per cent of their sleep during daylight hours. One fourth officer who had shown an above-average inability to sleep on his first long-range flight made another trip with the writer ten months later. This time he served as first officer and slept every time the opportunity presented itself. The only problem was in waking him.

Degree of Responsibility Aboard Ship

In general it may be said that the heads of the various departments on the ship obtain the least sleep among the men in those departments. The outstanding exception to this is found in the radio department, where there is no correlation between rank and ability to sleep.

Psychological Make-Up of Officers

Granted all of the above, it is still evident that there are certain men who are unable to adapt themselves sufficiently either to the watch and watch method of sleeping or to the idea of sleeping on an aircraft while it is under way. A man of this type is generally nervous, is deeply concerned to see that his job is well done, and pushes himself unreasonably to that end. If this analysis is correct, it should be possible to cure such a man of the bad habit of overwork. It has been the writer's experience that increased familiarity with both the job and the route has done much to calm down this type of personality. He eventually reaches the stage where he knows that he is competent in his job and learns to recognize when his work is for the moment complete.

Working Conditions

It is an unpleasant task to criticize the interior arrangement of the current types of long-range ships. Facilities are vastly improved over those of previous models, but the field for improvement is equally vast. It consists mainly in attention to small details that would not be noticed on a short flight but that become a persistant source of annoyance, irritation, and fatigue on trips of 200 hours. The space devoted to the crew is less than that contained in an average-sized living room. To appreciate the problem, invite eleven other men to join you in your living room. Ask them to bring their desks, their filing cabinets, their tools, their instruments. Invite them to stay for a fortnight. The twelve of you will work, eat, sleep, wash, and prepare your meals within the confines of these four walls, morning, noon, and night for days on end with only an occasional letup.

You will quickly recognize that the galley is no place for crews' rest quarters and vice versa. A careful layout of the normal flow of traffic is important so as to avoid points of high concentration (and equally high irritation).

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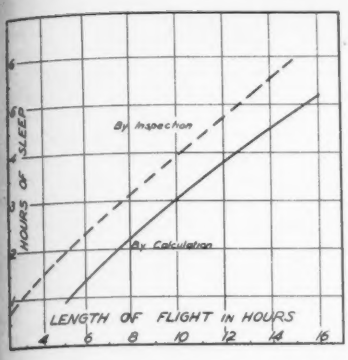

FIG. 4. Sleep available in flight as a function of length of flight.

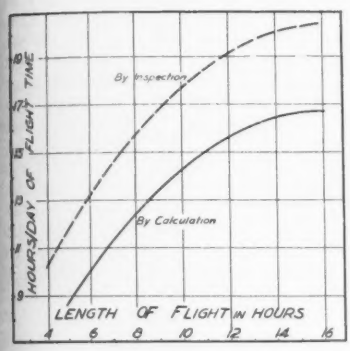

FIG. 5. Limitations imposed upon hours/day by the crew as a function of length of flight.

passing traffic. Each work station should be laid out so as to require of the operator a minimum of motion. It should be possible for him to do most of his work without leaving his post. Men are like machines in that motion produces friction and friction produces heat. This is particularly so where the clearances are small, as they are bound to be in an aircraft.

HOURS OF SLEEP BY LENGTH OF FLIGHT

Because of the many factors just enumerated, it is obviously difficult to say with assurance just how much sleep a crew will obtain within a certain time. Many of the variable factors are associated with overnight stops. Suppose that these are eliminated and that the ship continues as fast as it can be fueled. The remaining factor of maximum importance in controlling sleep is the length of the flight. Fig. 4 is a plot in two curves of hours of sleep as a function of length of flight. The curve giving the higher values was obtained from existing data which had been corrected for the other factors involved. The second curve giving the lower values was obtained by analyzing the duties of the key members of the crew and calculating for each length flight how much time was actually available for sleep. For operations over undeveloped airways even the lower curve is on the optomistic side. Data from these curves were used in developing the curves in Fig. 5 of flight hours per day as a function of length of flight, from the point of view of the endurance of the crew. In establishing these curves it was assumed that each member of the crew was entitled to an average of 8 hours of sleep out of every 24. Where sleep deficiencies occurred it was assumed that the flight was broken to provide a layover of 12 hours, of which 6 was credited to sleep. The upper curve of Fig. 5 represents values that could be obtained right now by a careful consideration of the factors enumerated and subordinating all other considerations to them. This curve is of particular interest because for flights of from 13½ hours on, it is identical with the curve of Fig. 1 for ship performance. In other words, under these conditions for flights of above 13½ hours the endurance of the crew matches that of the ship. Fig. 6 is a plot of ton-hours per day against length of flight using the data of the curves of Fig. 5 combined with the curve of Fig. 2. The lower curve of Fig. 5 represents what was accomplished by the flight crews during the development period. The interesting point about these curves was that even the lower one showed values for flight hours per day above what were actually being obtained in the operation. There must, then, have been other factors more limiting to the operation than either the limitations imposed by the ship or the limitations imposed by the crew.

HARBOR RESTRICTIONS

Many of the ports then in use were not available for operations 24 hours of the day. Some were not usable at night, some had but limited meteorologic facilities, and some were restricted for military reasons. One schedule touched at eleven such ports. On an average they were available for departures less than 11 hours out of each 24. The 16 ports used by one division were usable for departures less than 10 hours a day. Making a schedule that must use these ports and at the same time develop a high figure for hours per day was an utter impossibility. The curve of Fig. 7 shows this in graphic form. The eleven ports served by the above-mentioned schedule are being considered. The average availability for this group of ports was 10.6 hours a day. In constructing the graph it was assumed that

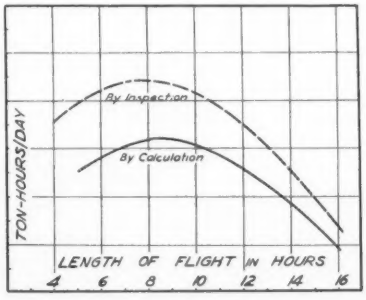

FIG. 6. Limitations imposed upon ton-hours/day by the crew as a function of length of flight.

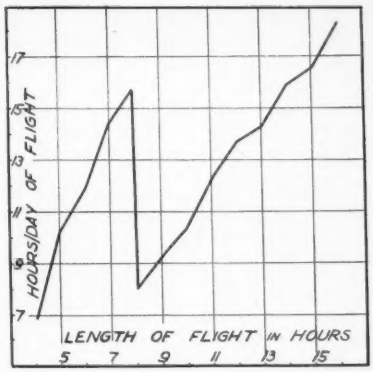

FIG. 7. Limitations imposed upon hours/day by port restrictions as a function of length of flight.

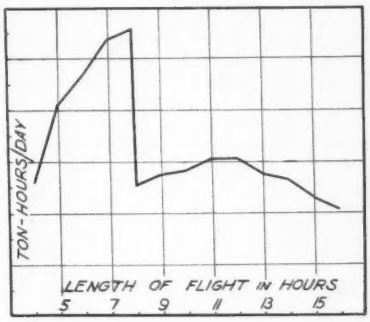

FIG. 8. Limitations imposed upon ton-hours/day by port restrictions as a function of length of flight.

the same hours of the day were available in each port. Fig. 7 shows the drastic effect upon hours per day imposed by this kind of operating regardless of the length of flight. The same effect is, of course, apparent in Fig. 8, which is derived from Fig. 7 and shows ton-hours plotted against length of flight and as affected by port restrictions.

WEATHER

Only those harbor restrictions have been discussed which have been imposed by purely physical or man-made elements. The effect of weather is closely interwoven with the other effects but rates separate consideration. Several years ago it was discovered that one of two coastal runs experienced a wide seasonal variation in block times. Both routes emanated from a common center using identical equipment and flight crews. One route ran through tropical latitudes; the other was a mid-latitude route. It was the mid-latitude route that showed the wide variation with a 12 per cent range in month-by-month block times. In 2 months of the year individual trips showed times that were 24 per cent below schedule. These month-by-month block times were plotted for a year's operation against three curves representing ceiling, visibility, and precipitation along the two routes under consideration. For the

tropical route the three weather curves followed each other rather closely—that is, when the ceilings were lowest, the visibility was poorest and the precipitation heaviest. The curve of block times for this route showed little variation throughout the year and relative indifference to the weather curves, excepting that it dipped slightly where the three weather curves simultaneously dipped. This proved only that weather affects operations. For the mid-latitude route the curves were entirely different. The three weather curves for this route showed complete independence of each other. During the month that precipitation was heaviest, visibility was near its best. In the month that showed poorest visibility, precipitation was least. The two months that had lowest ceilings had visibility well above average. It was during these two months of lowest ceilings that the curve of block times showed its greatest downward deflection. This is further confirmation of a general suspicion that low ceilings present the greatest limitation imposed upon operations by weather.

True ceiling is the vertical distance between the base of the clouds and the top of the highest obstruction within a certain radius of the landing area. The length of this radius will depend upon the maneuverability of the ship being landed and the precision and reliability of the equipment being used for the letdown. On these counts it is found that in most of the long-range operations a generous figure will be required for this radius. If within this radius there exists a 300-ft. obstruction, on days when the ceiling is 500 ft. the true ceiling is only 200 ft. This could be compared to a 200-ft. ceiling at a base that was free of obstructions. Actually, a landing under the latter circumstances would be both easier and safer. An isolated obstruction such as a chimney or tower is difficult to see and, because it is at right angles to the flight path, is difficult to avoid and disastrous if hit. A level landing area is more readily visible and, because it is tangent to the flight path at an acute angle, is more easily avoided and the consequences are not so severe if actual contact is made. What all this adds up to is that operations from a base that is located in an obstructed area are much more restricted than those conducted in an area free of obstructions. In terms of flight hours per day per ship this one factor has imposed a penalty of more than an hour per ship per day. The reverse effect has been beautifully demonstrated by one of the few well-located seaplane bases now in use. This base presents a large landing surface in an unobstructed area. Nearby is a landplane landing strip whose approaches are not quite so clear. For periods of a week at a time landplane operations have had to be cancelled because of the weather. But the seaplanes operating in an unobstructed area have maintained schedule without a single deviation for weather. Radio equipment is of the simplest, yet blind landings have been made repeatedly.

This base is unique only because it is one of the few places where advantage has been taken of natural geography. Similar opportunities exist over most routes and are studiously ignored. One of the main bases for transatlantic seaplane operations is in a location of which nothing can be said except that under favorable conditions seaplanes have been able to land there. It is located underneath one of the most highly congested air traffics in the world. Yet the entire Atlantic coast from Connecticut to Key West is an almost continuous string of potential seaplane bases equal to or better than the one mentioned above that had a 100 per cent operating score.

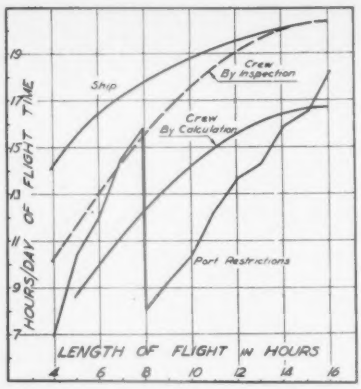

FIG. 9. Limitations imposed upon hours/day by ship, crew, and port restrictions as a function of length of flight.

The reason for the poor location of many of the bases used for long-range ships is fairly apparent. These bases were built either for short-range operations or by people whose psychology was that of a person trained in short-haul operating. For domestic operators to compete favorably with surface transportation they have been under the necessity of locating their airports as close to the sources of traffic as possible. In the economic balance between schedules cancelled because of poor terminal location on the one hand and time lost because of poor surface communications between airport and place of business on the other hand, the latter element has carried the greater weight. However, in long-range operations the same balance does not hold good. There is a heavier penalty in cancellations because of poor airport location, and there is a smaller reward for reduced travel time from airport to office. Determining just where the balance lies is outside the province of a discussion of operational problems. It is sufficient to say that in order to develop maximum operating efficiency the bases for long-range aircraft must be better than most of those now used.

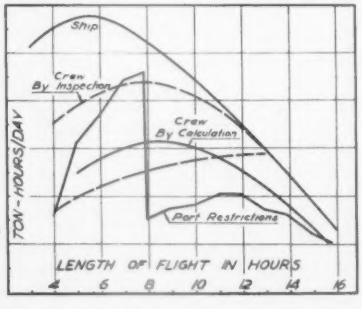

FIG. 10. Limitations imposed upon ton-hours/day by ship, crew, and port restrictions as a function of length of flight.

BLUEPRINTING AN IDEAL OPERATION

On the basis of what has already been discussed, an attempt will be made to outline what would be an ideal operation. All of the curves showing limitations imposed upon hours per day per ship have been united in Fig. 9. Those relating to ton-hours per day per ship are gathered together in Fig. 10. Both a maintenance-of-the-route type of operation and a maximum tonnage type of operation will be considered, using Figs. 9 and 10, respectively, in the planning. It is immediately apparent from both curves that the limitations imposed by harbor restrictions must be removed. Selecting better ports eliminates not only this restriction but also the more than an hour per day per ship penalty that must otherwise be applied to all of the curves to allow for delays because of weather. Unless the ports now used are changed for better ones, a figure of approximately 10 hours per day per ship (on the route) will have to be accepted as maximum.

Assuming that the ports have been improved and this curve removed from the calculations, the next limitation is imposed by the crews. First consider the case of a maintenance-of-the-route service. Suppose that the fixed cabin load will call for the carriage of 30 passengers and their baggage and a ton of mail and express. From Fig. 2 it is found that this load will permit a flight of 14 hours. Referring back to Fig. 9 it is found that, for flights of 14 hours, from $16^1/_2$ to more than 20 hours per day per ship can be obtained, depending upon how much consideration is given to the crew. The upper limit will permit the use of one crew for the entire schedule and still give the best performance obtainable from the ship. This is worth trying for. It will call for reworking the crews' working and living space on the ship. Maximum assistance must be provided them at each port so that the ship will lay over a minimum of time and so that, if possible, the crew and preferably the entire ship's company may eat ashore. This will not only relieve the stewards but will also give each crew member an additional off-watch aboard for sleeping that would otherwise be consumed in eating. Operation will be continuous with only stops every 14 hours and no layovers. The alternative to this method will be the periodic substitution of fresh crews or the acceptance of the figure of $16^1/_2$ hours a day.

(Continued on page 151)

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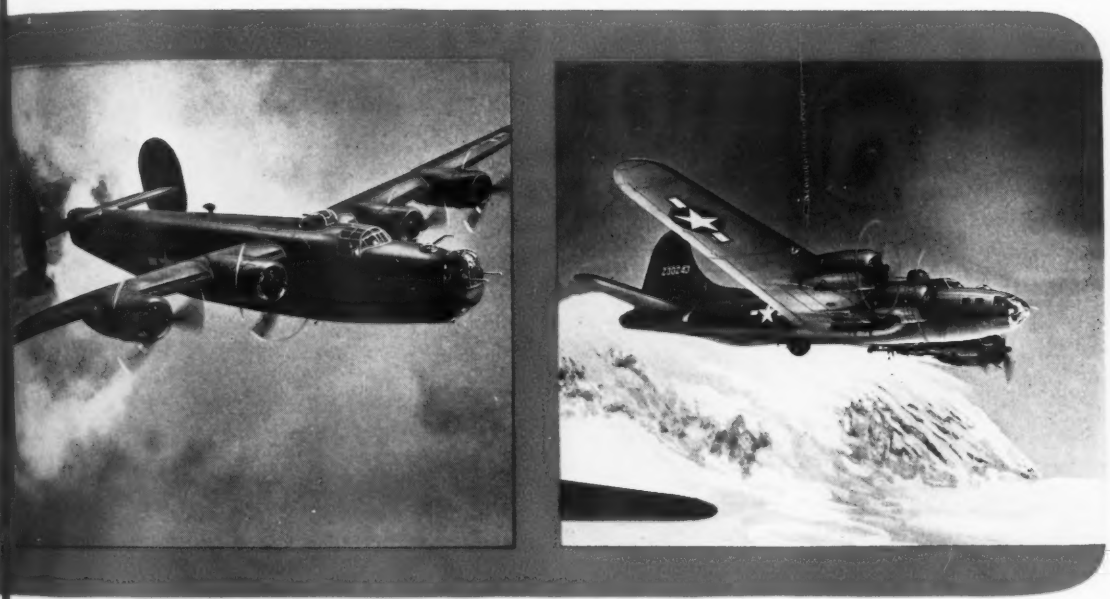

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In 1940, the B-24 was rated at 41,000 gross weight. Today, published figures rate it at 65,000 pounds, an increase of over 50%. From a half-dozen machine guns to a complement of over a dozen with four power turrets, from aluminum gas tanks to bullet-sealing fuel cells and with ten tons of bombs, this great bomber has grown into one of the most potent offensive weapons of the United Nations.

Even with a 50% increase in load, the 56" tire size that equipped the original Liberator still does the job. Lighter, U.S. Royal Rayons replaced heavier, bulkier cotton cords. And today, more "muscle," more strength to carry the thirty-ton load is built into new Nylon tires supplied in large quantity by "U.S." to the Army Air Force.

B-17 Boeing Flying Fortress—The very words, Flying Fortress, have become the symbol of deadly, long-range bombing power. The achievements of the Fortress and its heroic crews in precision bombing have earned it a distinguished place in the history of World War II.

In 1940, the rated gross weight of the Flying Fortress was 45,470 pounds. Today with thirteen heavy guns, with bullet-sealing fuel cells carrying long-range supplies of gas, with ten tons of bomb load, the Fortress weighs approximately 65,000 pounds—an increase of over 45%!

In 1940, the Fortress landed its 45,000 pounds on 19.00 x 23 tires. Today, with 65,000 pounds and more, the tire size has been increased only slightly. "U.S." tire engineers first built tires with rayon bodies as gross weight increased. They carried the load over rough landing fields at higher and higher speeds. Then came U.S. Royals with Nylon bodies delivering 64% more strength than rayon tires!

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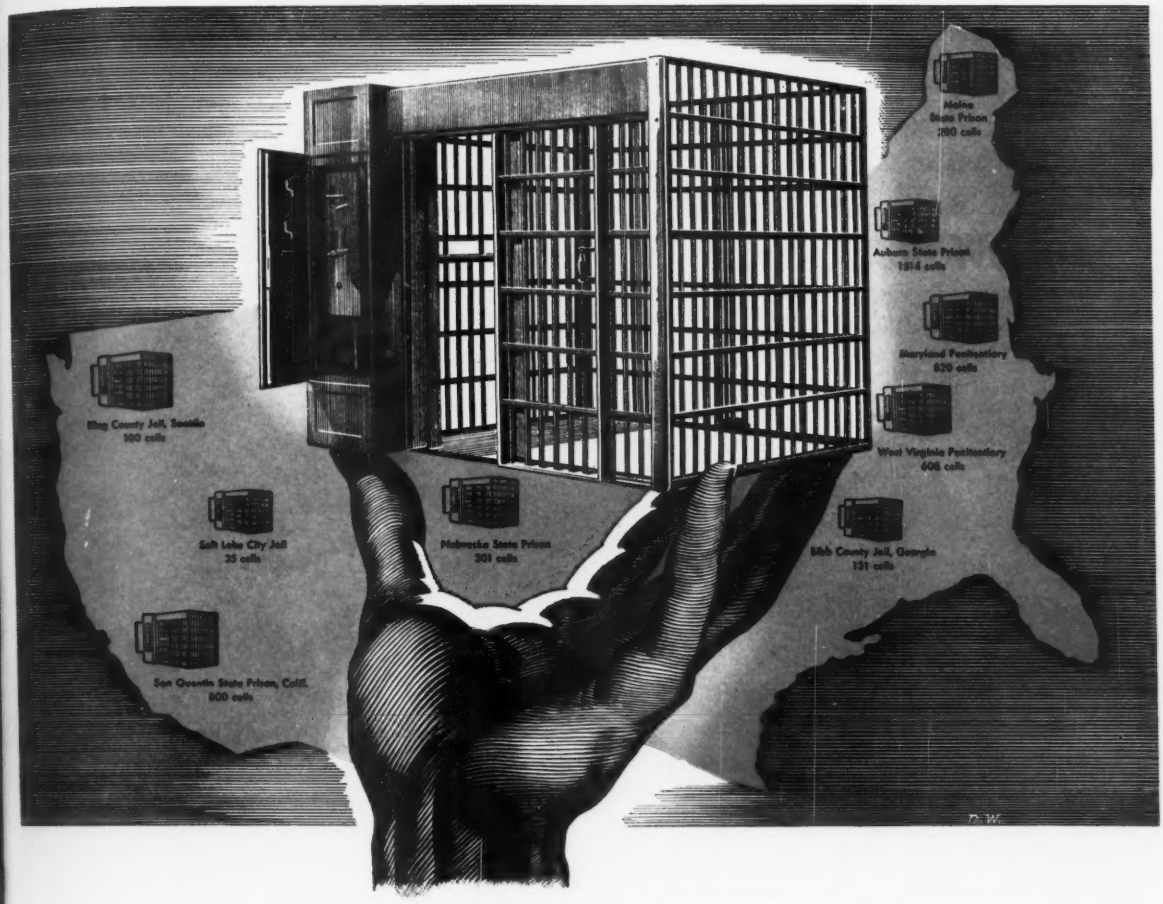
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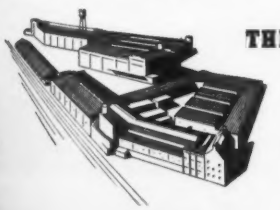

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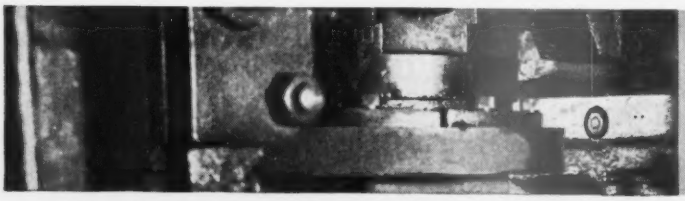

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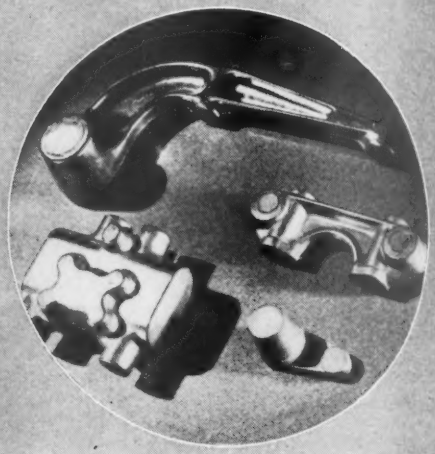

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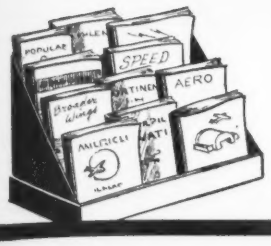


Periodicals

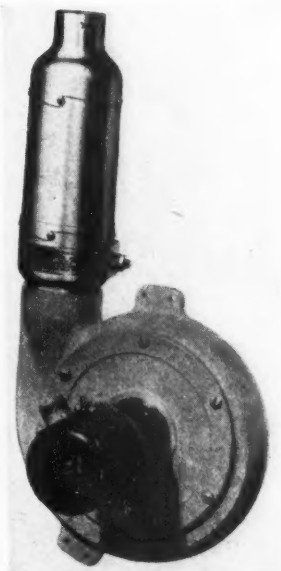
Accessories

An Aircraft Double Windshield—Its Development and Use. R. L. McBrien. Means for the elimination of ice on windshields which have been tried by various organizations are outlined. It is explained that the three chief losses that have to be compensated when heat methods are employed result from the formation of ice caused by: (1) the impact of subcooled water droplets; (2) evaporation freezing; (3) heat lost to the air flowing over the windshield.

The development of the double windshield currently used by United Air Lines is discussed, with mention of the shortcomings of the several transparent materials used in the installation. It is stated that experience during the past two winters has proved that adequate heat can be supplied to the double windshield from the cabin heating system of the DC-3 airplane to prevent ice from obscuring vision in all except the most severe conditions encountered in scheduled operation.

The optical characteristics of the two-pane installation are found to be somewhat inferior to those of a single pane but are more than offset by improved ice protection and by increased strength to resist the impacts of birds. *S.A.E. Journal*, October, 1943, pages 350–355 (Transactions), 14 illus.

The Slow Combustion Cartridge Emergency System. H. D. Shaw. The action and operation of a combustible cartridge system for emergency lowering of aircraft undercarriages are explained. Invented by F. H. Hall and developed in conjunction with the Bristol Aeroplane Company, this system has been successfully applied to different Bristol airplane models. It employs a special cartridge that is burned in a combustion chamber so designed as to allow the cartridge to burn slowly and to generate the back pressure required for controlled combustion. Combustion time can be regulated within limits of approximately 2 to 20 sec.



The Avia self-contained aircraft heater operates on 24 to 28 volts d.c. and can be made to deliver from 600 to 6,000 B.t.u. per hour, depending on the specific application. (*See* page 165.)

It is claimed that combustion is silent, without shock; that there is no excessive heat; that the temperature rarely exceeds 150°C.; and that the resultant gas is inert. Fully automatic, the Hall cartridge system is said to compare favorably in speed with hydraulic hand-pump operated systems and is suggested for other uses, such as the charging of an air bottle for machine-gun and cannon controls, inflation of high-pressure under-carriages, etc. *The Aeroplane*, August 6, 1943, page 159, 4 illus.

Aerodynamics

Experimental Investigations in Aircraft Dynamics. William B. Bergen. This paper represents a report on some of the vibration studies that have been made at The Glenn L. Martin Company. It is divided into three sections in which vibrations emanating from the power plant, flutter, and dynamic loads are discussed. With the exception of powerplant vibrations, where methods of design control are treated from an analytic point of view, the main body of the paper is concerned with experimental vibration studies involving both wind-tunnel and flight tests.

The development of electrical vibration recording equipment especially designed to meet the rigid requirements of aircraft flutter testing is described in the light of tests first conducted in 1937 on an early Martin Clipper and continued on other models, including the large Navy flying boat, Mars. One particular feature of these tests is the use of a mechanical vibrator that is remotely controlled to produce artificial excitation in flight.

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The third phase of the paper is concerned with measurements made to determine dynamic loads encountered by aircraft structures under service conditions. It is shown, for example, that dynamic loads whose magnitudes exceed present static requirements are encountered on nose-wheel struts. In conclusion, the paper discusses the preliminary results of a program, conducted in cooperation with the Bureau of Aeronautics, to measure the landing and take-off accelerations encountered by flying boat hulls. *Journal of the Aeronautical Sciences*, October, 1943, pages 233–249, 35 illus.

Aspect Ratio Corrections. K. D. Wood. Customary calculations of aspect ratio correction for lift curve slope are shown to be in error by as much as 30 per cent for aspect ratios of 1.5 or less. The assumptions and results of various theoretic analyses are summarized, and a new form of plotting is proposed showing the discrepancies between various theories and between theory and experiment. Simple empirical equations consistent with acceptable theory are proposed which closely approximate the experimental results.

A new method is also proposed for estimating the airplane efficiency factor e often used in aspect ratio corrections for induced drag, taking account of the size and shape of the fuselage as well as the wing aspect ratio. *Journal of the Aeronautical Sciences*, October, 1943, pages 270–272, 2 illus.

Characteristics of Airfoils in a Cylindric Axial-Flow Grid. John R. Weske and Frank E. Marble. Results are presented of an experimental investigation of a rotating cylindric axial-flow grid of airfoils. Measurements of pressure distribution over the cylindric mid-section of the airfoil were obtained for several blade spacings and angular settings and under various operating conditions. These data were used to compute the lift characteristics. The possibility of supplementing pressure distribution measurements by wake traverses for the determination of profile drag was explored. *Journal of the Aeronautical Sciences*, October, 1943, pages 289–294, 14 illus.

Letters to the Editor. In a letter to the editor referring to a paper titled "The Influence of Sweep on the Spanwise Lift Distribution of Wings," by F. Theilheimer appearing in the JOURNAL OF THE AERONAUTICAL SCIENCES for March, 1943, comments are made by Albert Gail. He states that he has studied the same topic and has arrived at the same, or essentially the same, expressions as the writer of the paper, but that his formulations invariably lead to nonexisting integrals. Mr. Gail suggests certain changes in the equation developed by the writer and calls attention to a paper by Hermann Blenk in a German periodical, an excerpt of which was published in July,

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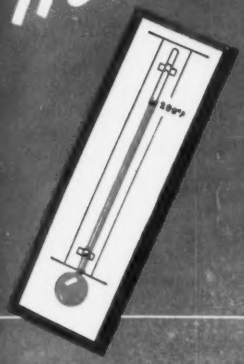

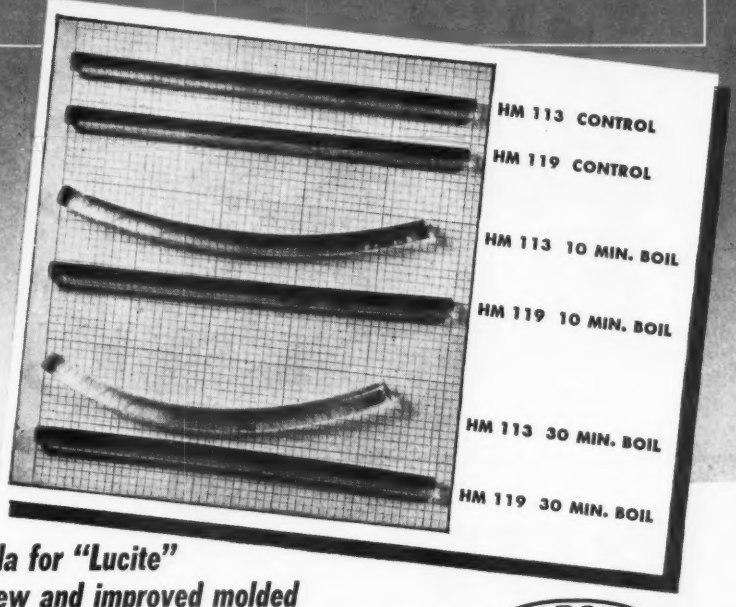

AT RIGHT—unretouched photograph of test rods extrusion-molded from General Purpose "Lucite" (formula HM-113) and from *heat-resistant* "Lucite" (formula HM-119). **AT TOP**, 5" rods before heat treatment. After 10 minutes' boiling in water (212°F), rod molded from General Purpose "Lucite" **(CENTER)** shows dimensional change of 8%, and after 30 minutes' boiling, 14.5% change. Rods molded from *heat-resistant* "Lucite" showed no change in form, or in mechanical, thermal, optical, molding or general properties, even after 30 minutes' boiling. (Heat resistance is influenced also by extrusion variables.) This test, employing rods of a single diameter, suggests how *heat-resistant* "Lucite" will allow creation of many new molded acrylic products to serve more purposes than ever before.

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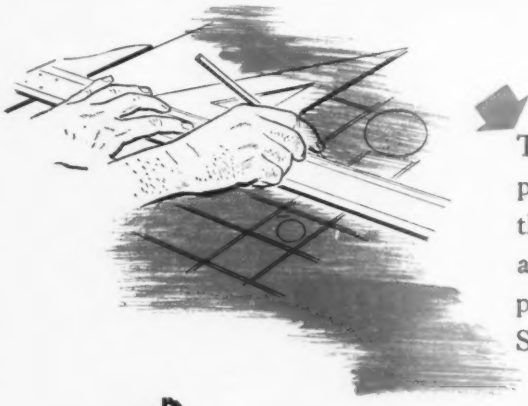

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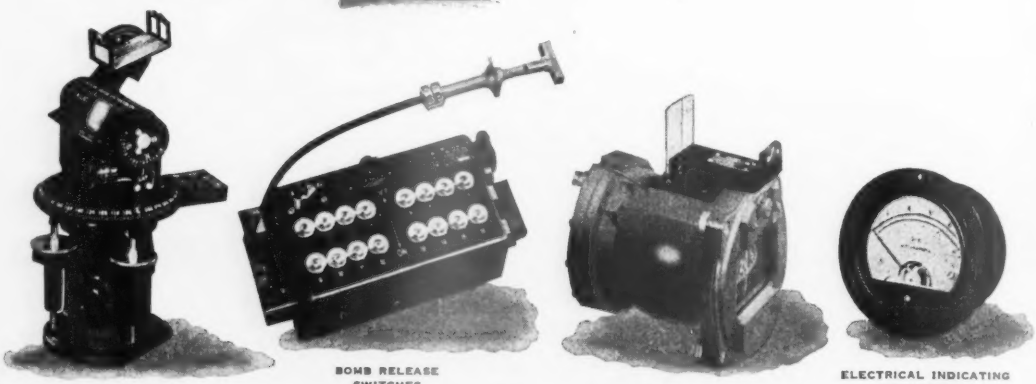

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1934, issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

Mr. Theilheimer replies to the foregoing comments on the use of a vortex system consisting of a finite number of vortices. He shows that exactly the same situation prevails in the case of the straight lifting line and demonstrates how the principal value of the integral in question is derived. *Journal of the Aeronautical Sciences*, October, 1943, pages 319–321.

The Lateral Stability of Aeroplanes. H. L. Price. Part II of a series of articles presenting a new geometric system of determining the lateral stability of airplanes. The derivatives are discussed under sections covering the correlation of notations; methods of calculating derivatives; values of the individual derivatives; contributions from the wing, fuselage, tail, and dihedral derivatives; a summary of the values of derivatives; and a geometric representation of the stability boundaries. *Aircraft Engineering*, August, 1943, pages 228–233, 3 illus.

Air Cargo

Merchandising by Air. L. Welch Pogue. Indicating the potentialities of air cargo after the war, the Chairman of the Civil Aeronautics Board demonstrates the economic feasibility of shipping commodities by air from a merchandising point of view. Although he takes into consideration the lower rates that will be available because of reduced operating costs, improved equipment, and better facilities, he is mainly concerned with the savings that will accrue to manufacturer and consumer alike from the speedier method of transportation. He discusses the lesser amount of packing, transshipment in international shipping practice, and warehousing that will be necessitated when cargo is shipped by air. In addition, he points out the importance of speed in delivering perishables, the fact that airplanes can reach places where no modern surface transport facilities exist, and the effect of speedy delivery upon the need for the merchant to place his orders weeks or months in advance.

With regard to the competition between air and surface transportation the writer states that he does not believe all commodities will be shipped by air. He lists those that are most adaptable to air transportation and predicts that new articles that will be placed in the channels of trade by air cargo will be instrumental in producing business for surface transportation systems. *Southern Flight*, September, 1943, pages 26, 27, 30, 50, 2 illus.

Global Shipping in Fiber Containers. Demonstrating the advantages of fiber containers for shipping commodities by air, this article discusses the factors that determine the proper selection of fiber container for each product. The governing considerations are: the characteristics of the commodity to be shipped, transit time, destination, and handling. Several tables in the article include the following information: Federal overseas shipping requirements for exterior corrugated and solid fiber packing; Railway Express requirements for solid, corrugated fiber containers; Federal guide to choice of interior packing for overseas shipments; Federal specifications for length of shipments to be loaded in cargo with no auxiliary fuel tanks installed; Federal overseas shipping requirement for interior corrugated solid fiber packing. *Flying*, October, 1943, pages 10–12, Air Commerce Department, 2 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Time to Stop Debunking Air Cargo. William M. Sheehan. Claiming that too many people have been trying to spotlight the difficulties attendant upon shipping by air, the writer answers their objections and reiterates the advantages of this method of transportation. He points out that air cargo does not involve the right-of-way and maintenance costs that have burdened the railroads; that it avoids the costly, time-consuming, transshipments characteristic of water-borne movements; and that it offers a transport service far faster than that of surface mediums. *Skyways*, October, 1943, pages 33, 64, 74, 4 illus.

Air Cargo. Part 3. Harry S. Pack. The third article in this series on postwar air cargo is concerned with air terminals and arrangements of facilities for the economic handling of air cargo. Fifteen general requirements are listed for air terminals and four general types of terminals are specified—three at airports and one at a convenient location in the city. With diagrammed plans for the layout and procedures of each type, the three terminals at airports are placed in these classifications: (1) the small feeder-line operation that will devote a portion of the passenger terminal to the cargo activities; (2) the medium-size terminal for use on secondary routes (in which the cargo handling should be kept away from the passenger operation if possible); and (3) the large terminal, such as will be required for cities like New York, Chicago, San Francisco, etc. Among the improvements envisioned for the postwar air terminal are rail and truck loading docks and conveyerized handling equipment. *Flying*, October, 1943, pages 14–17, 22, Air Commerce Department, 6 illus.

Air Power

Bombing... The American Way. Part II. E. Eugene Miller. The second of two articles on American doctrines and methods of employing bombardment forces is devoted to a discussion of the fundamental factors that govern the most efficient use of aircraft types for this purpose. Although the tactical employment of bombers is noted, the bombing function is designated principally as one of strategic force. Operating techniques, altitude considerations, loss ratios, and formation flying are among the factors given detailed examination. A table summarizes the effects of altitude upon bombing and defense considerations at various ranges from under 300 to over 25,000 ft. *Aviation*, September, 1943, pages 118, 119, 333, 335, 337, 338, 341, 3 illus.

Air Strategy for Victory. Gen. Henry H. Arnold. The Commanding General of the U.S. Army Air Forces explains the strategic use of air power and reviews several campaigns and missions that illustrate the effectiveness of strategic bombing. Briefly describing the long-range, offensive, precision bombardment principles of American air doctrine, he also notes the additional use of the U.S. air power in its tactical and logistic applications. Those illustrations of strategic air power presented are: the North African campaign; the mission against the German submarine works at Vegesack in March, 1943; the mission against the U-boat yards at Kiel in May, 1943; the Bismark Sea battle; the attack on the Rumanian oil refineries at Floesti; and the conquest of Pantelleria. *Flying*, October, 1943, pages 50, 51, 352, 353, 1 illus.

Analysis of Air Warfare. Hanson Baldwin. Featuring the role played by air power, this is a survey of war news during the summer of 1943. Developments in air warfare on the Mediterranean, Western European, and Pacific fronts are reviewed. In the Mediterranean, it is shown how air power opened the sea and land roads for the invasion of Sicily and helped to shorten the Sicilian campaign. In Europe, two events are marked particularly One is the increase in weight and accuracy of the American daylight-bombing effort; the other is the participation in the raids upon Europe for the first time of the newly formed Air Support Command of the Eighth Air Force. In the Pacific, it is noted that the combination of planes and ships spearheaded the summer offensives. The writer's analysis includes mention of various

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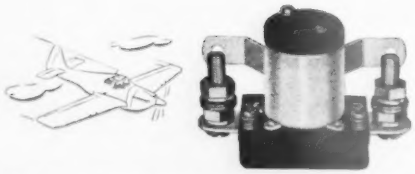

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American airplanes that were effective on the different fronts. *Skyways*, October, 1943, pages 36, 37, 50, 80, 6 illus.

The Myth of "Fortress Europe." Major Alexander P. de Seversky. The writer's thesis is that the conception of Europe as an impregnable fortress can only be sustained when regarded with outmoded ideas of surface strategy, since the unroofed "fortress" is extremely vulnerable to attack from air power. He explains why a defensive strategy could not protect Germany from air attack as it could from surface attack.... indicating that the only real air defense is an offensive against the enemy's source of air power. In the case of the Battle of Britain, he claims, the British Isles were favored by a discrepancy in weapons and strategic good sense which the Germans cannot hope to duplicate. However, the writer goes on to state that, in spite of Europe's vulnerability to air attack as opposed to her ability to withstand surface attacks, political factors may outweigh military considerations and a land invasion may be attempted. *The American Mercury*, October, 1943, pages 417–421.

War in the Air. A discussion of how new global concepts of time and space dictate the overall strategy that guides the use of the U.S. air forces. Indicating why the air forces must be employed both as a separate striking power and in coordination with ground forces, four functions are ascribed to them. One is air defense, the second air support, the third air power, and the fourth air service. In conclusion the article imposes four guiding principles, listed as object lessons of World War II. These are: (1) Air power is not a panacea; (2) air power must not be developed at the expense of land power; (3) we will never again be given the opportunity to build air power after it is needed; (4) air power has added a third dimension to statesmanship as well as to war. A map showing the air distances between cities all over the world and a chart of an American task force service command organization outside United States continental limits are included among the illustrations. *Flying*, October, 1943, pages 71–75, 6 illus.

Italy's Air Power. V. L. Gruberg. Symptoms of the Regia Aeronautica's waning strength and progressive weakness are traced in this assessment of Italy's air power. The lack of raw materials is stressed, while other deficiencies—such as the shortage of fuel and the unfavorable locational distribution of the aircraft industry—are pointed out. Italy's poor position with regard to supplies is indicated by a survey of various essential war materials and her strained production by an estimate of her output capacity and related problems. Mentioning the tax put upon her air strength by the Abyssinian and Spanish wars, the article also includes a brief review of current Italian aircraft and engine types. *Flight*, August 19, 1943, pages 193–196, 6 illus.; "Exit Italy's Air Force," by Robert Mont, *Air Trails*, October, 1943, pages 18, 19, 64, 68, 7 illus.

Balance Sheet of Area Bombing. Peter G. Masefield. Analyzed like a profit and loss sheet, the results of British night bombing against German industrial areas are assessed in terms of the destruction caused to the enemy's war effort. Estimates are numerically calculated and presented as a guide for future estimates. The basis for assessment is the number of man-hours lost to German war production through each ton (2,240 lbs.) of bombs dropped at night. On present experience, this is judged to be 8,000 man-hours per British ton—4,000 man-hours in loss of work to the enemy, and 4,000 man-hours in extra work necessitated by repairs, replacements, etc. Figures are listed for the destruction caused by each night-bombing sortie and the cost to the British also in terms of man-hours. When figures for American daylight attacks are added to these, it is shown that, at the rate of destruction to which Allied air attacks upon Germany are expected to be increased, about 250 million man-hours of damage will result. *The Aeroplane*, August 13, 1943, pages 183–187, 7 illus.

Air Transport

The Steamship Companies' Place in Air Transport. F. D. Fremd. A statement of the American steamship companies' views of why they should be permitted to own and operate air lines. Based upon claims of their experience in transoceanic commerce, it is reported that they may be expected to launch a strenuous campaign after the war against the Civil Aeronautics Board's prohibitory policy regarding air-carrier control by steamship companies. It is denied that steamship companies would discourage the development of transoceanic flying so that greater profits could be realized on their present investments; it is claimed that these companies do not fear the direct competition of the airplane in transoceanic trade; and their concern about air transportation is attributed to the fact that a ship company's service unaugmented by its own air service may find itself at a serious disadvantage in competing with foreign concerns or governments able to offer the combined facilities. A similar campaign on the part of British shipping interests is pointed out, although it is stated that the British steamship lines are apprehensive of a governmental monopoly in the field of commercial ocean flying while their American counterparts fear a monopoly by one or two privately owned air lines. *Flying*, October, 1943, pages 5, 6, 23, 24, Air Commerce Department, 2 illus.

Banana Run. John Foster, Jr. The fourfold job of the Domestic Transportation Division of the U.S. Army Air Forces Air Transport Command in its route from Brownsville, Tex., to the Panama Canal Zone is depicted by a report of a typical round trip. It is shown how the so-called "Banana Run" efficiently delivers men and materials where they are needed, gives young army pilots valuable transport training, contributes an effective diplomatic service, and is compiling a store of operating and maintenance experience in record time. *Aviation*, September, 1943, pages 114, 115, 314, 317, 318, 320, 321, 3 illus.

The Air Transport Command and the Air Lines. Major Gen. Harold Lee George. Military achievements of the Air Transport Command are outlined. It is pointed out that the war has brought about what might be called a forced growth in air transport. The effect of this growth on postwar air transport is discussed. It is stated that there is already a network of air routes which makes readily accessible every part of the world under United Nations control. Almost unique in warfare is the fact that the money and effort necessarily spent to create this network is not merely serving to help win the war but can also be considered as a direct investment for the era of peace that will follow victory. *Air Transport*, September, 1943, pages 22–25, 7 illus.

The Airlines Take Part in the War. Col. Edgar S. Gorrell. The President of the Air Transport Association of America relates how prewar planning on the part of the commercial air lines paved the way for U.S. Army Air Forces' ferrying, rapid war mobilization, and global transport. Among the wartime activities of the air lines which he surveys are: the transportation of personnel and material by air for the Army and Navy; the staffing of many important positions in the military effort; the maintenance and overhaul of military airplanes; the training of military ground and flying personnel; the building of airports and airways for the war effort. *Flying*, October, 1943, pages 7, 22, Air Commerce Department, 1 illus.

Aircraft Designer—Operator Liaison Urged. E. J. Foley. While the significance aircraft manufacturers are attaching to industrial market research is a healthy sign, it is stated that the funnel-like function of market research needs to be supplemented by close personal liaison between manufacturer and operator if aircraft are to be "transportation vehicles." Although it is stated as doubtful that any concerted air transport industry move toward extensive close collaboration will be made, the individual air-line action in this direction may really be more effective. Each air line may be the best judge of its own needs in this regard.

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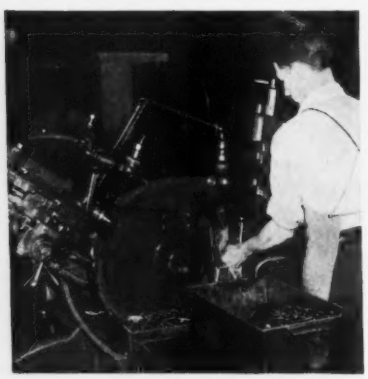

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should be widely expanded to include all manufacturers of air-line equipment who wish to have the "best" to sell in the postwar market. *American Aviation*, October 1, 1943, pages 70, 71, 7 illus.

Impressions of a Tour of 20,000 Miles to Speed Inter-American Growth. Eric A. Johnston. The President of the Chamber of Commerce of the United States of America discusses impressions gained during a recent 20,000-mile tour by air through seven Latin-American republics as chairman of the United States Commission for Inter-American Development. The tour convinced him that just as private enterprise is the method, so aviation is the means of unlocking the door of industrialization in Latin America. The high state of development air transport has already reached in Latin America is described. Future air transport development is discussed. *Air Transportation*, September, 1943, pages 36–38, 1 illus.

El Transporte Aereo Inter-Americano y los Aeropuertos. (Inter-American Air Transport and Airports.) This article considers the future of Inter-American air transport, especially as it may affect Latin America. The importance of proper airports is stressed, particularly that such facilities must be properly designed and properly located. The fact that money expended on existing seaports brings such good returns should be kept in mind by authorities when planning the construction of new airports or the enlargement of airports now in actual operation. *Mundo Aeronautico*, June, 1943, pages 9, 10.

Non-Stop Trans-Atlantic Record. A report of a new record for non-stop transatlantic flight. Made by a Trans-Canada Airlines transport flying from Montreal to Britain, the trip was accomplished in 12 hours and 26 min. *Commercial Aviation*, August, 1943, page 86, 3 illus.

"Wings for Warriers." The story of the First Troop Carrier Command is told with the aid of pictures. How the I.T.C.C. transports troops and equipment to the battle zones of the world is described. The organization and history of the Command is outlined. *The American Pilot*, September, 1943, pages 12–14, 30, 6 illus.

Airplane Descriptions

A Russian Fighter. Based upon information derived from neutral and enemy sources, this is a detailed study of the characteristics of the Lagg-3, Russian single-seater fighter. Data are presented under the headings of: performance and structure; the undercarriage; balancing of controls; power plant; engine data; performance; radiator and airscrew; and fire protection and armament. The structural strength and low weight of the Lagg-3 are designated as its most outstanding features. With a top

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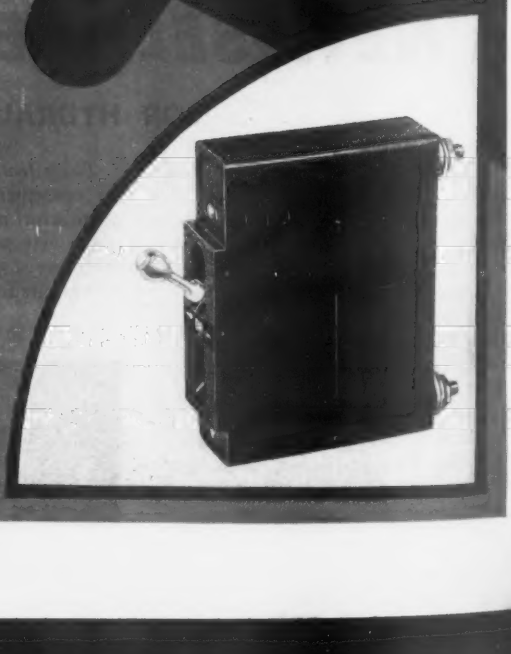

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speed of 350 m.p.h. and a cruising speed of 279 m.p.h. at 16,400 ft., the fighter is reported to have a range of 400 miles and a service ceiling of 29,500 ft. It is of all-wood construction, powered by a twelve-cylinder V-type engine. *Flight*, August 12, 1943, pages 178–180, 7 illus.; "The Russian Fighter the Lagg-3," *The Aeroplane*, August 13, 1943, page 175, 2 illus.; "The Lagg-3," *The Aeroplane Spotter*, September 9, 1943, page 207, 2 illus.; "Russian Fighter Lagg-3," *Automotive and Aviation Industries*, October 1, 1943, pages 30–32, 60, 61, 8 illus.

The Russian Air Fleet. A compendium of Russian warplanes. Photographs illustrate the bombers and fighters listed. In some cases, identification of the Russian planes is not certain and designations are not given. *Skyways*, October, 1943, pages 42–49, 36 illus.

Aeroplanes of the Red Air Force. A full-page tabulation gives a summary of the specifications of aircraft operating in the service of the Russian air forces. It covers the name, in English and Russian; the designer; the type of duty; the engines; dimensions; weights; maximum speeds; and size of crew for 64 types of military aircraft, including American and British designs. *The Aeroplane Spotter*, September 9, 1943, page 208.

Sweden's New Fighter. Based upon information and illustrations from a Swedish magazine, this is a series of notes on the design and construction of the Swedish fighter, J22. With manufacture of the J22 prompted by Sweden's inability to obtain delivery of foreign aircraft, the fighter was designed to be built of "home-grown" materials by dispersed firms not normally engaged in aircraft work. Special designs that had to be taken into account because of this situation are considered.

The J22 is described as being of mixed construction, with an all-wood wing (except for the flaps and ailerons, which have a framework of spot-welded stainless steel and fabric covering) and a fuselage having a welded steel tube primary structure covered with birch plywood. Its radial engine appears to be a Pratt & Whitney twin-Wasp with a Hamilton Standard three-bladed propeller. The unusual features of the tail, in which the rudder is wholly aft of the elevator, are stressed. *Flight*, August 26, 1943, pages 221, 222, 4 illus.

Production-Plus ... On Fleet-Fairchild "Cornell" and PT-26A. William A. Hunter. Supplemented by some notes on the history of Fleet Aircraft Ltd., of Fort Erie, its policies and its production procedures, this is a description of the Cornell and PT-26A planes manufactured by Fleet Aircraft for the British Commonwealth Training Plan. Differences between the Cornell—Canadian version of Fairchild training planes—and its United States' originals are indicated, as well as differences between the Cornell and the PT-26A (also called Cornell II). Details on the two trainers are submitted under the following headings: specifications and construction, construction detail, tail assembly, rudder and longerons, undercarriage, and cockpit layout. Additional topical headings regarding the planes' construction are: Auxiliary equipment, other specifications, aircraft dimensions, other characteristics, wood wing construction, center section, and mahogany plywood. Specifications of the two airplanes are tabulated. *Commercial Aviation*, August, 1943, pages 46–48, 53, 54, 56, 58, 26 illus.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

L2M. Leighton Collins. An analysis is given of Taylorcraft's L2M series of liaison planes. Its evolution is traced, and the plane is compared with its predecessors. Special reference is made to new instruments and accessories. The article also discusses the advantages of the light plane and its future. Features of light aircraft and their suitability for civilian use are discussed at length, particularly the employment of spoilers and the technique of flying with them. *Air Facts*, October, 1943, pages 50–66, 4 illus.

Torpedo Beaufighter. Accompanied by a series of photographs, information is given on the employment of the Bristol Beaufighter as a torpedo carrier. It is reported that the fitting of the torpedo has reduced the maximum speed of the plane at sea level to approximately 300 m.p.h. With two improved Bristol Hercules engines developed from those used in the standard fighter type, the total weight of the torpedo Beaufighter has increased from 21,000 to 25,000 lbs. Stalling speed is about 80 m.p.h. and, despite the wing loading of over 49 lbs. per sq.ft., the Beaufighter with torpedo clears a 50-ft. obstacle in 750 yards. *Flight*, September 2, 1943, pages 253–255, 16 illus.

New Trainer Is Developed A description of the Rawdon T-1 trainer, which is stated to be adaptable to field operations with army ground troops because it can land in a minimum size rough field. Its high rate of climb and high service ceiling are stated to make it particularly suitable for high-altitude landings and take-offs.

The plane has a useful load of 540 lbs. and a service ceiling of over 17,000 ft. with an initial rate of climb, with full load, of more than 900 ft. per min. The range is more than 400 miles. It has a span of slightly over 33 ft., an overall length of 24 ft., and is powered by the new Lycoming, four-cylinder, 125-hp. engine.

The maximum use is made of nonstrategic materials. The wings are of wood construction, the fuselage is of steel tubing, and the whole airplane is fabric-covered. Many features have been worked into the design to make it a good production airplane, such as straight nontapered wing and ailerons interchangeable right and left. All four lower wing and landing-gear brace struts are completely interchangeable with each other. The wheel tread is 9½ ft. to provide ground stability in strong winds. *The American Pilot*, September, 1943, pages 23, 24, 3 illus.

The Tunisian "Aero Show." Beginning of a two-part article on Axis equipment during the final stages of the North African campaign. Part I deals with the German and Italian transport aircraft that were employed. The Me 323 and the Ju 290 (captioned in the German press as the Ju 90S) are described in detail and certain features of the Ju 52 are noted. Among the Italian planes, the S.M. 82, the Fiat G.12, and the S.M. 75 are mentioned. Reviewed in less detail but reported as also having been pressed into service by the Germans for transport purposes are the FW 200C, Ju 90, Ju 88, Me 110, Bu 222 flying boat, GO 242, and DFS 230 (the latter two are towed gliders.) *Flight*, September 2, 1943, pages 257–261, 9 illus.

Airports

Planning the Modern Airport Terminal. Maurice Roddy. A series of notes with regard to the planning of postwar airports in Illinois. It is reported that the future overall airport planning for the Chicago area calls for at least three major airports, a group of connecting inner and outer "belt" air terminals, and 30 secondary fields designed to serve commercial and private nonscheduled flights and scheduled feeder service to major airports. Contemplated features of these airports are given. *Flying*, October, 1943, pages 18–20, 22, 23, Air Commerce Department, 6 illus.

Armament

Wings, Bombs, and Bullets. Gen. H. H. Arnold. The Commanding General of the U.S. Army Air Forces describes the effectiveness and efficiency of the Ordnance service with the Air Forces. The fall of Pantelleria is reviewed as a dramatic demonstration of what modern air power can do. Today's air operations are compared with those of World War I. The history of the arming of aircraft

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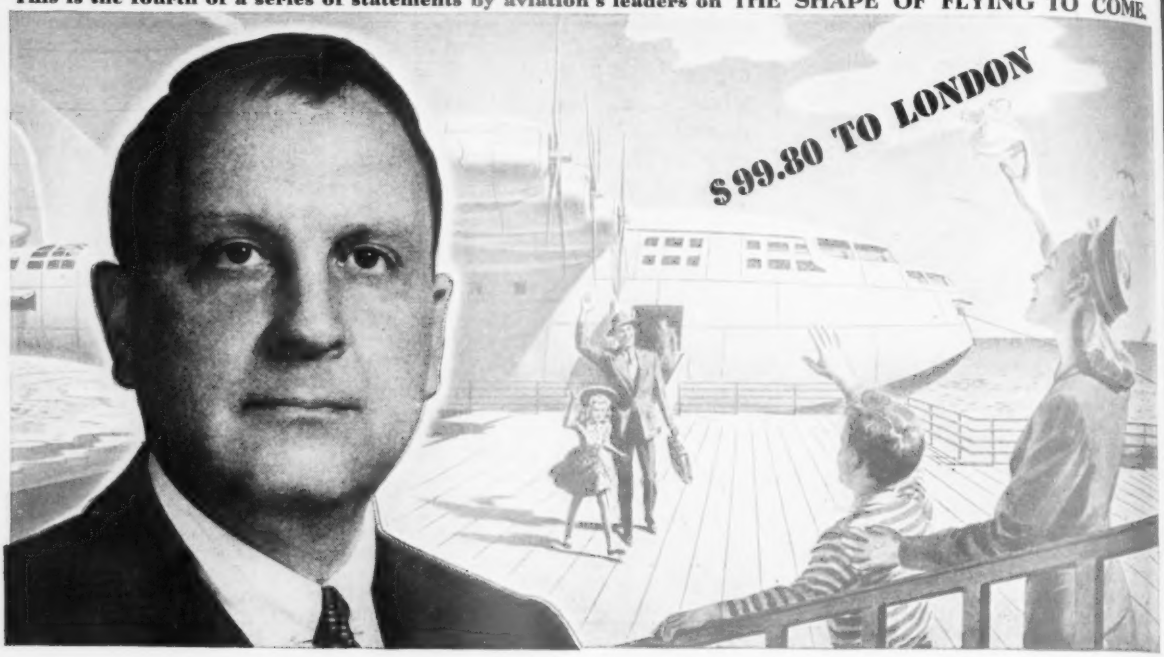

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is outlined. It is explained that up until the late 1920's, demolition bomb construction was based on a design of cast sections welded to plate steel. At that time it was realized that targets for bombs were increasing in toughness and resistance. The forged bomb case was introduced, which had a tensile strength of 90,000 lbs. per sq.in. This required heavy forging machinery that would not be available for war production. To meet this difficulty, a combined forged and welded bomb was fabricated. The investigation led to the present general-purpose bomb, which has a minimum case strength of 105,000 lbs. per sq.in. whether forged or welded.

The general-purpose bomb is made in five sizes, and the damage that each size will produce is listed. The effectiveness of semiarmor-piercing bombs, fragmentation bombs, and chemical bombs is described. It is explained that the perfection of our armament in combat can only be obtained by the full cooperation between the Ordnance designers in their work on weapons and ammunition and the Air Forces designers in their work on airplanes to carry these weapons and ammunition. Predictions for bombers of the future are made. *Army Ordnance*, September-October, 1943, pages 317–320, 1 illus.

Ordnance with the Air Forces. Col. Harold J. Conway. The organization and development of the General Headquarters Air Force are described. How this branch of the Ordnance Department carries out the servicing of guns, bombs, and ammunition for the Army Air Forces is outlined. A chart shows the organization of Air Forces' supply in a theater of operations. *Army Ordnance*, September-October, 1943, pages 338–340, 1 illus.

The Bombsight. An examination of the scientific principles and mathematical calculations upon which bombsight operation is based. Some of the problems that confront bombsight inventors are reviewed. Defining the bombsight as an automatic speed and distance calculator that interprets its findings in the form of an angle, the article gives the features of two general types of sighting mechanisms, the "timing" type and the "synchronous" type. *Flying*, October, 1943, pages 103–107, 342–344, 9 illus.

More Firepower for Liberators. Changes in the armament of the B-24 bomber are noted. Consolidated Vultee engineers at Fort Worth, Tex., have increased its heavy fire power by installing an Emerson powered gun turret in the nose and replacing the older-type belly guns with the Sperry ball turret with automatic computing sight. *Southern Flight*, September, 1943, page 31, 2 illus.

Aerial Firepower. The great strides that have been made in the development of military airplanes and aircraft armament are outlined and illustrated. The growth of the Air Forces is traced briefly from the purchase of the first military airplane from the Wright Brothers in 1909, through its status at the entrance of the United States into World War I, to the present strength of the Army's air arm and its equipment. Photographs of the Boeing B-17, Consolidated B-24, North American B-25, Lockheed P-38, Bell P-39, Republic P-47, and North American P-51 are included. *Army Ordnance*, September-October, 1943, pages 341–348, 15 illus.

Bombs. An article on the different types of bombs used by the U.S. Army Air Forces and the specific characteristics of each type. Details are given on demolition, fragmentation, chemical, practice, and drill and gauge bombs. In the demolition classification, the features of general purpose (50 to 55 per cent explosive), semiarmor-piercing (32 per cent explosive), armor-piercing (5 to 12 per cent explosive), light case (77 per cent explosive), and depth (70 to 75 per cent explosive) bombs are described. In the fragmentation classification, antipersonnel and antiaircraft types are noted. In the chemical classification, use of the following agents is marked: gases of the type called harrassing agents, casualty agents, screening smoke, and incendiary agents. In addition to the mention of certain bombing techniques, the article also outlines three fundamental rules for the employment of bombs. These are: (1) Always use a bomb of sufficient size to accomplish the destruction desired; (2) having determined the proper size of bomb, never use a heavier bomb, but carry more of the right weight bombs and thus increase the probability of securing the necessary hits; (3) select the fuse that will give the maximum effect against the given target. *Flying*, October, 1943, pages 111, 112, 268, 5 illus.

Modern Aircraft Armament Design. Donald G. Smith. A survey of the developments in the design of armament for airplanes. In his discussion the writer touches upon fire power of certain gun and cannon types; location of guns; mounting structures; ammunition containers, belts, and feed chutes; methods of gun charging; gun heaters; and bomb-rack installations. Mine-dropping, depth-charge dropping, and torpedo-launching airplanes are mentioned as other armament developments closely coordinated with bombing. *Warplanes of the World*, No. 2, pages 78–81, 94–96, 5 illus.

Avigation

Computer Confusion. Lt. Larry J. Fisher. A simplified explanation of the use of the EB-6 type navigational computer. The application of this computer to the following problems is followed through in detail: "Off-course-correction;" two different types of wind problems; finding wind direction and velocity; wind from ground speeds; and wind from drift measurements. *Southern Flight*, September, 1943, pages 40, 42, 44, 46, 48, 15 illus.

Bearings

Increasing Capacity of Ball Reciprocating Bearings. S. R. Thomas. What has been called a "ball reciprocating bearing" is defined as a bearing capable of both rotation and axial reciprocation. Such a bearing is described, and the applications for which it is suitable are outlined, with comments on the three principal alternatives open in designing for the greatest load-carrying capacity for a given size. The first two alternatives concern the qualities of hardness and uniformity of parts, accuracy of manufacture, and proper design. The third alternative, with which the article deals principally, is by increasing the number of balls, thereby attaining a proportionate gain in capacity. The method is explained in detail, with a demonstration of the mathematical calculation involved in determining the capacity of the bearing. The article concludes with a list of the applications for which such bearings are used. *Aero Digest*, September, 1943, pages 191, 272, 3 illus.

Business and Finance

Reconversion Reserves—They're Postwar Worry No. 1. Raymond L. Hoadley. Indicating why the need for reconversion reserves is more urgent for aircraft manufacturers than for manufacturers who normally produce other commodities, the writer advises the aircraft industry and industries in like predicaments to unite on a program of remedial measures and present it to Congress. He suggests for consideration the Canadian plan of allowing a 20 per cent postwar tax credit for industrial corporations. In the meantime, he offers the following advice for companies seeking postwar financial stability: (1) Keep your finances as liquid as possible—particularly your reserves. (2) Plan your operations so you will not be caught with excessive inventories in critical periods when raw material prices are tobogganing. (3) Develop a capital expenditure budget and an operating budget for the reconversion period which may come sooner than expected. *Aviation*, September, 1943, pages 179, 295, 296.

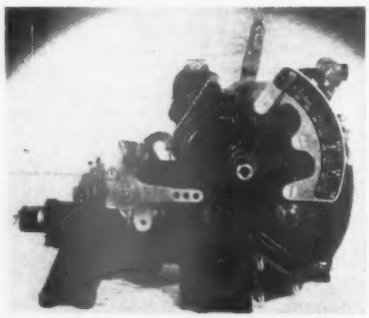
What Price... Price Control? Styles Bridges. Demonstrating some of the weakness in the present renegotiation law, a U.S. Senator states that Congress will have to settle three fundamental questions: whether the law should be repealed; whether there should be a price-control substitute in lieu of the present system; and how much of the good and constructive parts of the regulation can be retained through wise amendments.

He indicates several issues that will have to be dealt with by the subcommittee of the House Ways and Means Committee concerned with the law. These issues include: (1) the fact that the funds accruing from contract renegotiations are retained on Army, Navy, and Maritime Commission books and are available for respending without reappropriation by Congress; (2) allowances in renegotiation for postwar reserves; (3) the question of depreciation of plants and facilities; (4) whether renegotiation is proper before or after taxes; (5) the general subject of amortization of values of manufacturing properties.

The writer proposes that industry be permitted to purchase Government war bonds with all profits above a certain level. It is his belief that some postwar cushioning should be provided to protect contractors in the event that hostilities are terminated precipitantly. *Skyways*, October, 1943, pages 27, 66, 1 illus.

Government Will Require Months for Contract Cancellation Plan. Blaine Stubblefield. Plans for solving the problems arising from the cancellation of war contracts are discussed with reference to the war industries in general and the aircraft industry in particular. Desires of the industry with regard to compensation for canceled contracts are stated to include mandatory advance payments amounting to as much as 90 per cent of the cancellation; authority for prime contractors for amounts up to $25,000, while subcontracts for larger amounts would be settled by the Government on a 90 per cent basis; compensation for termination expenses, such as unexpired leases; separation pay for employees; and provision for reimbursement of other costs. Two major bills now being considered in Congress are summarized. One calls for advances of not less than 75 per cent of the amount certified by the contractor as due him, on which payment would be required within 30 days, and for loans on the remaining 25 per cent. Another bill, introduced at the request of the War Department, would give authority to the Secretary of War to settle contract terminations at his own discretion. *Aviation News*, September 20, 1943, pages 21, 22.

Wanted: A Haven for Aviation Securities. H. L. Federman. An analysis of the proportion of aircraft equities in investment trust holdings shows that to a great degree both airline and aircraft-manufacturing stocks have been eliminated. In addition to regular investment trusts excluding aviation equities from their holdings, it is reported that even the National Aviation Investment Fund—established to deal exclusively in aviation securities—has invested in other industries. However, the hope is offered that certain of the issues identified with the aircraft industry may receive stimulation from outside sources



A new model of the Simmonds-Hobson automatic engine control to coordinate manifold pressure and mixture is now in production. The unit has a die-cast body. (*See* page 175.)

—notably, through the recognition of electronics and the possibility of aircraft organizations turning their facilities to this application. The combined aviation holdings of 20 major general investment trusts, as of June 30, 1943, are tabulated.... listing the number of trusts holding stocks of six major air transport companies and seven major aircraft manufacturers, and also the total shares held in each company. *Aviation*, September, 1943, pages 183, 305, 306.

Control Equipment

Resonant Electrical Control Systems. David William Moore, Jr. This paper describes a simple electrical position-repeating and control system. Its operation is based upon the change in the phase relationship between the current and voltage in a series-resonant circuit as the tuning of the resonant circuit is varied. The control system sensitivity is a function of the Q of the resonant circuits employed and is high for values of Q which may be easily obtained in normal practice.

The application of this principle to the control of low and substantial amounts of power is discussed and practical circuits are proposed. No electrical contacts are required in any of the circuits, which permits the design of an extremely reliable instrument.

The paper is concluded with a brief description of the application of this resonant control principle to single- and multichannel radio control to which it is well suited. *Journal of the Aeronautical Sciences*, October, 1943, pages 285–288, 321, 7 illus.

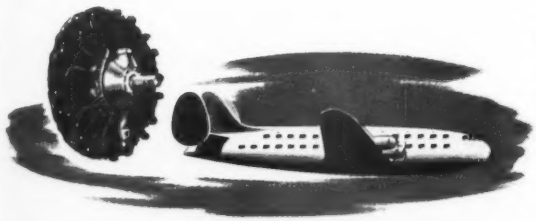
Aircraft Contactors. F. J. Russell and A. P. Charbonneau. A paper on magnetically operated switches or relays suited to the complex electrical systems in use on modern aircraft. The article is confined to a discussion of low-voltage d.c. power relays or contactors because most aircraft in use at the present time have 24-volt d.c. systems. Special conditions affecting the design of aircraft switches are discussed, and some aircraft accessories using contactors are listed. The design of contactors is considered under sections dealing with the contacts, the magnet, and arrangement, mounting, and special features. Curves show the arcing time for various contact pressures and coil voltages. A contactor force analysis is also presented. It is concluded that contactors designed particularly for use on aircraft may be smaller and lighter than those having comparable current ratings used commercially. *Electrical Engineering*, September, 1943, pages 563–566, Transactions, 8 illus.

Maintenance of Electronic Control Devices. W. D. Cockrell. Procedures are suggested for maintaining and checking electronic control devices. The similarity of electronic control parts to those of magnetic controls is shown, and special emphasis is placed upon inspection routines for cleanliness and vibration effects. Indicating the damage to tubes caused by shocks and jars, ways of preventing such disturbances are outlined. The desirability of correct voltage is stressed. In advising methods for determining the causes of failures, the occurrences of failure are divided into three categories: when the equipment is new; when starting after a normal shutdown; and during operation. *Aero Digest*, September, 1943, pages 211, 213, 282, 283, 5 illus.

Manual Switches for Aircraft. R. A. Millermaster. The problem of obtaining complete field data for use in connection with the design and application of aircraft electrical control equipment is discussed. It is explained that three factors contribute to the difficulty: (1) The tremendous engineering effort centered in the aircraft industry causes rapid technical changes that soon make accumulated data obsolete. (2) Technical data on utilization devices are not always available to either the aircraft or electrical manufacturer. The mushroom growth and technical advance of the aircraft industry have, in some cases, outdistanced laboratory equipment and personnel capacity so the data an electrical-control manufacturer would like to have are simply not available. (3) The secrecy surrounding many aircraft developments blocks the passing of information from the aircraft manufacturer to the electrical manufacturer. The electrical-control manufacturer can meet this problem, in part, by making available complete performance data on switching equipment offered for sale.

Considerations in the preparation of such data of primary importance to both the user and the producer of switches are discussed in sections covering the functions of an aircraft switch and the characteristics of the load which affect the performance of these functions. *Electrical Engineering*, September, 1943, pages 596–598, Transactions, 6 illus.

WRIGHT POWERS THE TONNAGE OF THE AIR



This measuring glass contains slightly over half a pint of gasoline. Mixed with about 75 cubic feet of air and metered into a Cyclone 9 engine, this cupful of fuel, in contributing its share of the total power, will produce one horsepower for one hour.

No other type of gasoline engine does as much work on this amount of fuel; your car would require about 20% more gasoline to produce 1 horsepower for 1 hour. In engineering terms, the Cyclone's cruising consumption is at the rate of 0.41 pounds of fuel per horsepower per hour. Cyclones have operated on extended flights at cruising power on 0.39 pounds per horsepower hour — even less under careful control — but 0.41 represents the average for millions of hours of routine operation.

Minimum fuel consumption is determined by the engine design, depending on such factors as the compression ratio, the induction system, and the contour, size, and cooling of the combustion chamber. The carburetor's function is to provide the most desirable mixture for its engine under various conditions, but it cannot determine fuel economy because an engine will not run leaner at a given power than its design permits.

On a ten-hour flight in a four-engined airplane the seemingly fractional difference in consumption between the Cyclone 9's average lean rate of 0.41 lbs. and the general average rate of 0.45 lbs. can amount to a saving of 160 gallons. The fuel saved with Cyclones represents almost 1,000 pounds of extra cargo or five additional passengers. In a year, this difference can mean a saving of 50,000 gallons on a four-engined plane — fuel approximately equal in cost to an engine.

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Cargo planes are performing heroic service ferrying men and supplies to the fighting fronts. Almost always loaded to capacity, they are constantly subjected to terrific vibration stress by engines which must strain to the limit to lift the big ships from the ground and keep them in the air. That these planes are able to "take" severest vibration without "coming apart at the seams," is due largely to the vibration-proof Boots Self-Locking Nuts which protect them.

Boots Nuts are not only tough, they are also lighter than other nuts, save many pounds on each plane . . . thus allow for more cargo. In addition, they can be used and re-used as often as desired—literally "outlast the plane." Boots Self-Locking Nuts, standard for every type of U. S. aircraft, meet the exacting specifications of all government aviation agencies.

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Electric Remote Controls. William P. Lear. The writer explains the appearance and operation of electric remote controls for aircraft, to arouse interest in their application in future aircraft designs. He lists the various kinds and sizes of electric motors and the devices used to control them and to transmit their power. Advantages of electric remote control are summarized to include such features as reduced weight and bulk, simpler installation and service problems, less vulnerability under combat conditions, and more accurate positioning. Detailed descriptions are given of the control equipment manufactured by the firm headed by the writer, including actuators of various sizes and types, screw jacks, and other equipment. Changes in design resulting from experience with various motors are outlined, as well as those based on studies of the equipment of captured German aircraft. The advantageous features of synchronous d.c. motors in aircraft control equipment are outlined in considerable detail. *Western Flying*, September, 1943, pages 54, 57, 58, 3 illus.

Aircraft Inverter Construction. C. T. Button. Various classes of rotary inverters and control accessories are listed and a brief description is given of their characteristics and relative merits, viewed from the standpoint of the requirements of military aircraft. The operating requirements of the aircraft inverter which must operate on the direct-current supply of the plane and deliver alternating current are outlined. Basic types of rotary inverters are classified. Constructional details are discussed and the general conclusions are summarized. *Electrical Engineering*, September, 1943, pages 598–602, Transactions, 11 illus.

Design

Lofting Problems of Streamline Bodies. Part 17. Carter M. Hartley and Roy A. Liming. In the 17th of a series of articles on lofting techniques, the traditional procedures for providing coordinate information relative to station contours are outlined and their shortcomings are indicated. It is suggested that carefully and systematically prepared charts of fuselage data, coordinated precisely with the actual fuselage lines and so organized as to provide a complete and adequate picture of the dimensional features of each given fuselage frame, would be valuable.

Such information, including waterline-buttock line offsets for all desired fuselage stations (normal and canted), stringer coordinate data, and longeron basic data would provide useful information in the following functional respects:

(1) A check upon the accuracy of basic body plan view lines of the fuselage during the lofting process; (2) a check upon the accuracy of fuselage contour templates of all types; (3) engineering reference data for the development of body plan contours, whole or in part, to any desired scale; (4) the means for establishing any required point on the fuselage molded surface by direct calculations; (5) the basis for advance release of critical dimensions for engineering design and tooling use; and (6) the means for advance establishment of one centralized body of coordinated dimensional data for the use of engineering, lofting, tooling, and inspection.

A procedure is outlined for establishing the offset data and cross-checking the methods. The advantages and practical applications of these conic lofting techniques are listed. *Aero Digest*, September, 1943, pages 193, 195, 197, 4 illus.

Work in an Experimental Seaplane Tank. Leonard Smith. Tanks for the testing of seaplane models are discussed and research data obtained from seaplane tests conducted in a Short Brothers tank are presented. Fundamental problems connected with the design of seaplanes are considered. The growth of tank testing is outlined. The chief information that can be obtained through tank tests is discussed under sections covering water resistance during take-off, trimming moments at high speeds, dynamic longitudinal stability, water clearances, and take-off time and run. The method of conducting the tests is set forth and the evolution of the flying boat hull is described. *The Journal of The Royal Aeronautical Society*, September, 1943, pages 290–314, 25 illus.

Designing for Production. James E. Thompson. The sixth section of a series of articles continues the discussion of machined parts, with particular reference to the operations of turning, boring, and grinding. These operations are defined and information is given on the type of work for which each operation is employed. The discussion continues with explanations of turning and boring machines, including turret lathes, automatic screw machines, precision boring machines, and the particular ways in which designing should be done with a view toward the use of these machines in production. Emphasis is placed on economies that can be effected by avoiding the machining of mating radii to close tolerances and by holding the height of shoulders or flanges to a minimum.

In similar matter, explanations are given of the best ways to use boring and grinding machines, including the cylindrical grinder, internal grinding machine, centerless grinding machine, surface grinder, and disc grinder. Practices in grinding design involve the following considerations that must not be overlooked: (1) Provide undercuts when grinding to a shoulder. (2) Specify a ground diameter close to the stock size of the piece being ground. (3) Provide unrestricted plane surfaces for surface or disc grinding. (4) Provide well-distributed areas for surface or disc grinding. *Western Flying*, September, 1943, pages 64, 66, 68, 73, 74, 8 illus.

Design Approach for Long Range Aircraft. Part 1. Robert V. Boname. In the first article of a series a method is outlined for clarifying as much as possible the interdependence of the different factors involved in the design of long-range aircraft. It is intended to secure the optimum combination of values to be assigned to wing loading, power loading, and other principal aerodynamic characteristics in the development of an airplane for service over a particular distance. Two principal aspects are considered: the commercial or economic aspect of designing an airplane that will produce a profit for the operator on the basis of useful load carried per unit of operating cost, and the technical aspect dealing with tonnage, speed, altitude, and other engineering factors. The economic aspect is studied, leading to the selection of gross weight as a predeterminable basis for the design, with a view toward making sure that the aircraft of the gross weight assigned will be able to carry at least the pay load expected by the operator and as much more as possible.

A mathematical method is developed, having a new element consisting of the grouping of the system of equations that govern flight conditions, together with an equation of structural weight, and solving them so as to obtain the necessary characteristics for an optimum disposable load. The method is first exposed in a general way, outlining the theoretic aspects involved, and is then applied to a numeric example. Application of the equations to the calculation of wing area, weights, and power-plant estimate is explained, as well as the determination of suitable altitude, variation of air speed, and variation of the ratio of rated power. *Aviation*, September, 1943, pages 139–143, 296, 297, 7 illus.

The Airlines Design a Feeder Plane. Michael H. Froelich. A summary of the general specifications for a postwar feeder-line airplane recommended by an American Transport Association committee consisting of the chief engineers of eight air lines. Designated the ATA-A1, the design is for a multiengined type plane of about 30,000 lbs. gross, which will fly passengers and cargo on short-haul operations. Among its features is a movable bulkhead so planned that, in conjunction with folding or removable seats, it could

be moved to vary the size of the compartment to meet changing needs for space. The specifications of the ATA-A1 are reproduced under the headings of general characteristics, passenger provisions, baggage provisions, cargo provisions, performance, and balance requirements. *Flying*, October, 1943, pages 8, 9, 25, Air Commerce Department, 1 illus.

The Tandem Monoplane. C. M. Poulsen. After reviewing some early experiments with tandem-wing monoplanes, the writer speculates on whether the type might be worth reviving for certain specific purposes. He points out the advantages offered by the tandem monoplane in which the location of the center of gravity is less critical than in orthodox monoplanes and offers suggestions on how certain of its disadvantages might be overcome. The tandem is mentioned as being particularly adaptable for a twin-engined, two-seater fighter since, by suitable location of the main loads, it would afford an excellent field of fire for the rear gunner and an unobstructed view for the pilot.

In tracing the history of the tandem monoplane, an experimental craft made by a Gloucester firm in 1910, the Peyret-Maneyrol glider of 1922, and the Mignet design known as the "Pou-du-Ciel" are described. *Flight*, August 12, 1943, pages 167, 168, 3 illus.

Effect of Spinner and Cowl Entrance Combinations on Engine Cooling. Julius Jonas. A study is reported of the basis for the design for the combination of the cowl entrance and spinner, with reference to the effect of these entrance combinations on the cooling of air-cooled engines.

Assuming that a representative design condition is established and explaining why the twist imparted to the air stream by the spinner-propeller combination may be neglected, the writer demonstrates the action of the air pressure within the entrance to the cowling and around the spinner. Analysis of the problem is summarized in the following steps: (1) Determine the pressure distribution of the spinner for different angles of attack, corresponding to different flight conditions. (2) Assuming that the pressure distribution of the spinner up to the propeller plane of rotation is unaffected by the inlet velocity ratio, modify the pressure distribution past the propeller, using a linear pressure gradient established by different inlet velocity ratios, and by the internal diffuser ratio. (3) Determine the separation point by any one of the methods used to find the separation point for airfoils, selecting the vertical spinner section as the "design section." (4) Choose such a velocity ratio and such a spinner afterbody combination that the separation will be brought past the gap.

The writer suggests that the analysis would be greatly simplified by the standardization of spinner forms and adds that the thickness ratio and its corresponding critical speed should form a definite limiting factor in the selection of spinners. *Aviation*, September, 1943, pages 159, 286, 288, 1 illus.

Takeoff and Landing. Ray E. Marquardt and Robert De Vault. In a discussion of the basic principles involved in take-off and landing, the writers show that these requirements often have a stronger influence on the design than the desired flight characteristics. Take-off distance is defined, and methods are suggested for calculating mathematically the distance needed for the ground run of an airplane having given specifications. The questions involved are answered by computing the net forces acting on the airplane, the power thrust, the air drag, the rolling friction, and other elements, all of which are explained. Three methods of shortening the ground run through alterations in design are outlined, as well as various plans for providing an assisted take-off by means of external forces such as gravity and rockets. Mathematical formulas are offered for computing the climbing distance to clear obstacles of predetermined altitude.

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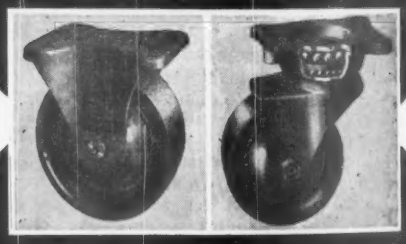

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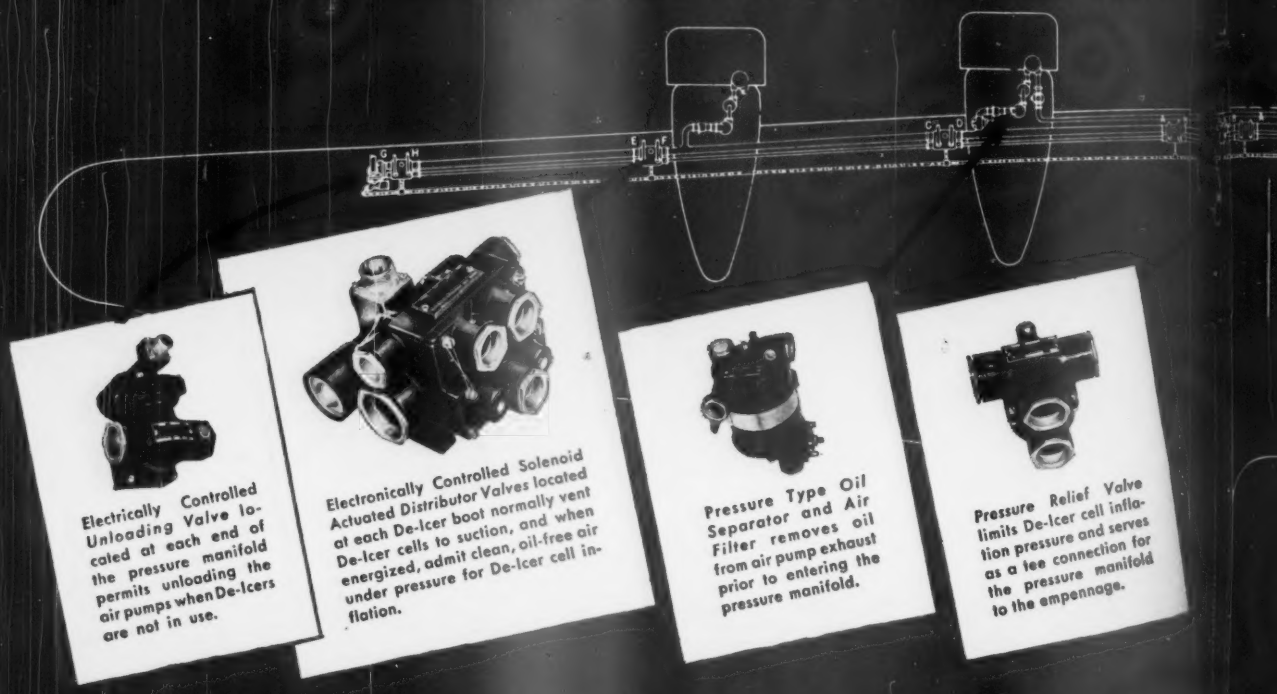

Electrically Controlled Unloading Valve located at each end of the pressure manifold permits unloading the air pumps when De-Icers are not in use.

Electronically Controlled Solenoid Actuated Distributor Valves located at each De-Icer boot normally vent De-Icer cells to suction, and when energized, admit clean, oil-free air under pressure for De-Icer cell inflation.

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Design Check Chart for Eclipse Manifold-Solenoid De-Icer System — Electronically Controlled

APPLICATION

To effect complete ice removal by the De-Icer method, accretion of ice must be permitted to develop a tensile strength sufficient to overcome adhesion between ice and inflated boot. The De-Icer system must accordingly be controlled for both rate of accretion and texture of ice formation. ***The Eclipse*Electronic De-Icer Control has been developed to accomplish this.***

The Eclipse Manifold-Solenoid De-Icer System with Electronic De-Icer Control in conjunction with B. F. Goodrich De-Icers installed on aircraft with wing spans in excess of 100 feet, provides a variable means of controlling frequency and duration of De-Icer operating cycles to suit any type and rate of ice formation.

PERFORMANCE

Provides a visible ***automatic*** or ***manual*** remote electrical control of wing and tail De-Icers.

Primary variable selector control permits variation of time between operating cycles to compensate for variations in rate of ice formation.

Secondary variable selector control permits variation of De-Icer cell inflation to compensate for variations in texture of ice formations and pump output during high altitude operation.

Push-button control permits manual operation of any individual De-Icer cell or cells when required.

DESIGN

Single span-wise ***suction and pressure manifolds*** provide a simplified, light-weight installation with negligible line losses. Pressure manifold acts as a reservoir, providing rapid and complete inflation of large boot sections.

Location of ***solenoid distributor valves*** adjacent to De-Icer boot connections also aids sudden and complete inflation of De-Icer cells.

Electronic timer permits variance of De-Icer inflation periods to correspond to individual De-Icer cell capacity, assuring complete inflation of all De-Icer boots.

Individual illuminated push-buttons permit manual operation of system independent of electronic relay. They also enable flight crew to determine proper functioning of De-Icer system at a glance.

De-Icer cells ***return to the deflated position*** in the event that pressure system, electrical system or any individual component becomes inoperative.

Current consumption is less than 6 amperes.

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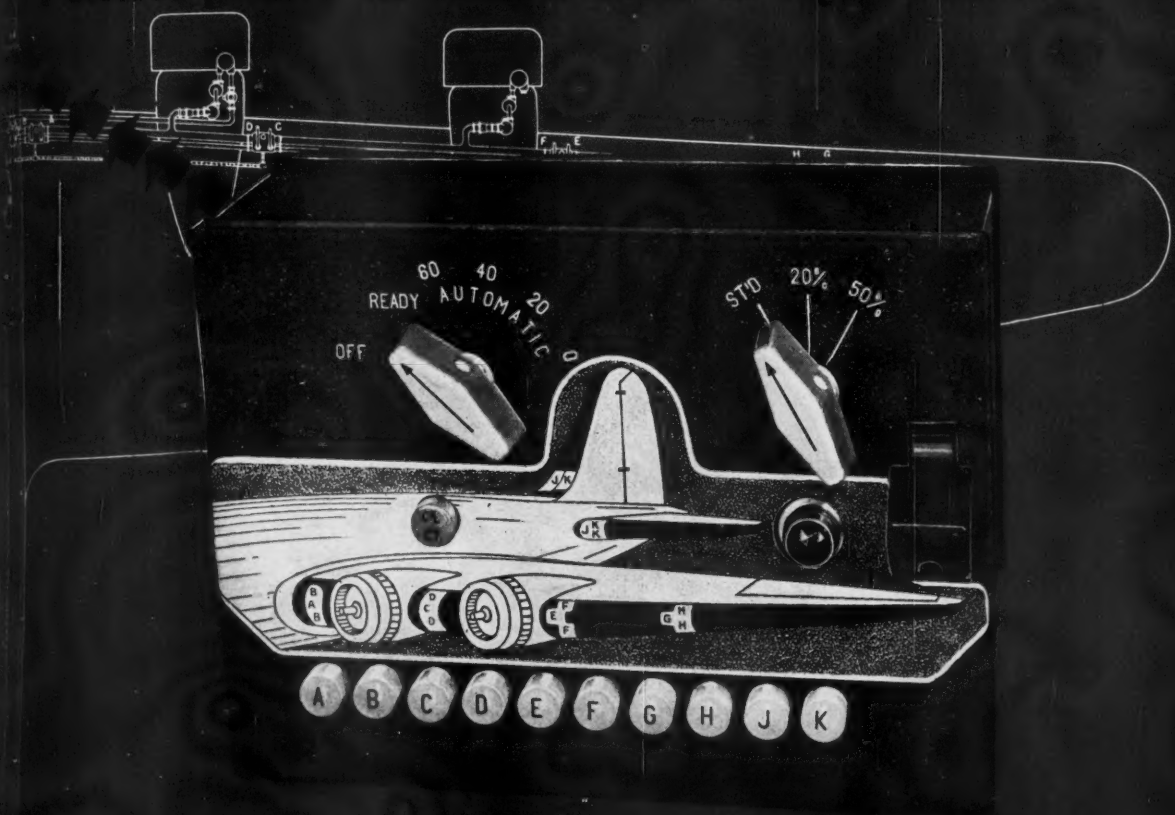
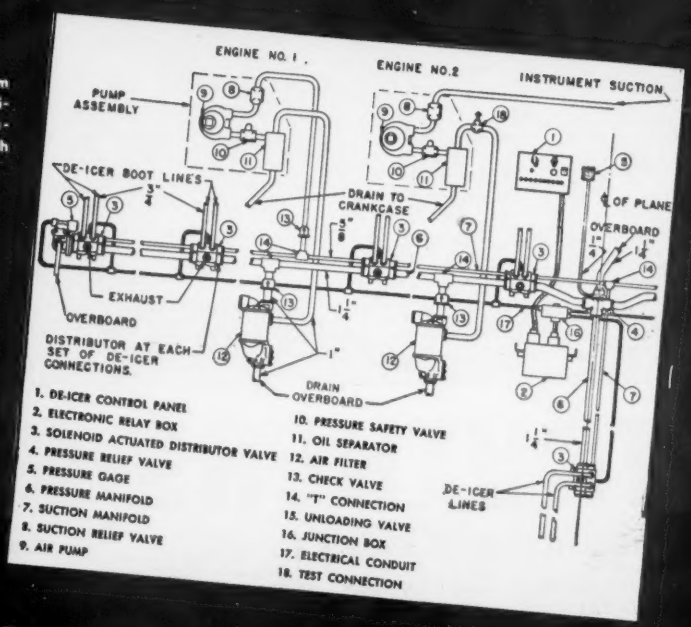


The *Electronic De-Icer Control* provides an automatic or manual means of controlling the frequency and duration of De-Icer operating cycles.

Schematic diagram of a typical Manifold-Solenoid De-Icer installation with Electronic Control.



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Ordinary relays weighing, say, one pound, may give a contact pressure of 3 or 4 ounces. By comparison, the Struthers-Dunn Series 61 D.C. Relays give 7 *pounds contact pressure in a unit weighing only 8 ounces!* Moreover, these famous Dunco "Nutcrackers" are especially designed to withstand shocks and vibration, and to operate faithfully without an enclosure in dirty or dusty places.

Although designed for D. C. use, their contacts will also handle A.C. They are supplied in various single and double pole types and are specifically recommended for any low-voltage d-c service where exceptionally strong contact pressure is desirable to secure maximum resistance to shock.

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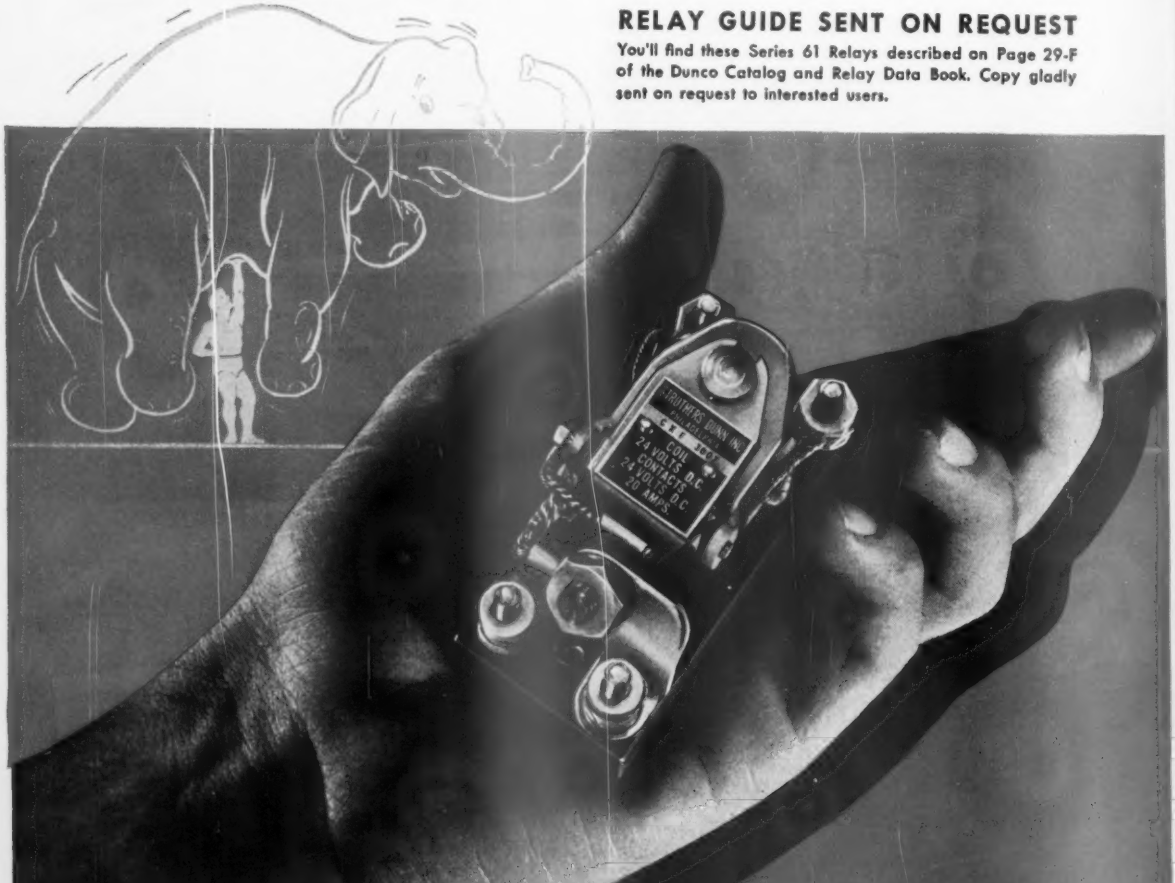
You'll find these Series 61 Relays described on Page 29-F of the Dunco Catalog and Relay Data Book. Copy gladly sent on request to interested users.



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The article ends with information on the selection of flaps for take-off. *Western Flying*, September, 1943, pages 78, 80, 82, 84, 86, 88, 14 illus.

The Blenheim Family. A detailed article on the evolution of the Bristol Blenheim bomber. Blenheim development is traced from the Bristol Type 135 transport, begun in 1934, to the latest Blenheim models—the 160 series. The article includes photographs of the various planes in the Blenheim series, as well as a table of data regarding their specifications. This table lists the data, type number, name of the planes, engines, purpose, span, loaded weight, maximum speed, height, maximum bomb load, range and cruising speed, numbers built, and general remarks. *The Aeroplane*, August 27, 1943, pages 239, 240, 241–245, 24 illus.

Engines

The Cheetah X. J. A. Oates. Second half of a two-part article on the manufacture of the Cheetah X engine by the Armstrong-Siddeley factories. This concluding installment deals with the operation of machining the cylinder unit and those connected with the induction-casing rear cover and the crankcase. Assembly and testing procedures are also examined. Description of the procedures begins under the headings cylinder barrel, removing the half-thread, grading, cylinder head, valve-guide holes, push-rod holes, valve seats and assembly. Subsequent topical headings are valve seat grinding, valves, cam drum, induction fan, induction-casing rear covers, drilling operations, assembly, and engine tests. Included in the illustrations are diagrams showing lathe-tooling setups for various cylinder barrel operations and a cross-sectional view of the Cheetah X seven-cylinder radial engine which includes information on its dimensions and performance. *Aircraft Production*, September, 1943, pages 418–428, 31 illus.

The Junkers Jumo 211B Series I Aero-motor. As issued by the Ministry of Aircraft Production, particulars are given on the Junkers Jumo 211B, Series I, inverted-Vee supercharged, gasoline-injection engines. Differing only in detail from the Jumo 211A as fitted in the Heinkel He 111H, the described engine was taken from a Junkers Ju 88 and differs greatly in installation. Specific data pertain to the crankshaft, supercharger control, operation, injection pump, aircraft fuel system, cooling, and exhaust heating system of the Jumo 211B, Series I engine. It is reported that some of the modifications from the 211A apply to the 211A Series III, and 211D. Series I. The specifications, weight and performance of the latter engine are also listed. *The Aeroplane*, August 6, 1943, pages 165–167, 6 illus.; August 13, 1943, pages 181 182, 4 illus.; "Type Testing the Jumo 211D," *Flight*, August 5, 1943, page 147, 1 illus.

The Junkers Jumo 211 Series. Further details of the Junkers Jumo 211 Series engines are revealed in this article, which is based on a British Ministry of Air Production report. The 211A engine, fitted with a two-speed supercharger, has 12 cylinders, arranged in inverted-Vee formation, and is liquid-cooled (Glysantin-water mixture), with direct fuel injection into the cylinders and spark ignition. The propeller is driven through spur reduction gearing.

It is explained that the general design follows established practice, but interesting features worthy of notice are the cylinder heads incorporating cooled exhaust valve guides and also the method of attaching the cylinder liners to the head, the position of the supercharger, the design of oil-scraper piston rings, and the use of single-piece split-cone cotters for valve-spring caps. A summary of the modifications to the later types of this series is furnished. *Flight*, August 26, 1943, pages 228–231, 6 illus.

Engine Differences — Me. 109E7 and 109F1–2. The detail differences between the German D.B. 601N engine and the D.B. 601A, and the differences in engine installation, controls, oil, coolant, and fuel systems from previous series of the Me 109 are examined. Particulars are reported under the following headings: engine; controls and engine limitations; coolant system; lubricating system; thermostat control of oil cooler and radiator flaps; fuel system; air intake, cowling and exhaust stubs; and general comment. *Commercial Aviation*, August, 1943, pages 98, 100, 102, 104, 106, 15 illus.

Mopping Up on Moisture. The use of silica gel for protecting aircraft engines from moisture and corrosion during shipment is described. Possessing high capillary action, this material is said to be able to absorb more than 45 per cent of its weight in water while still giving the appearance of being dry. It is claimed that 1 cu.in. of silica gel contains 50,000 sq.ft. of pore surface. The containers that hold the anticorrosion agent are made of injection-molded cellulose acetate butyrate. *Commercial Aviation*, August, 1943, page 118, 1 illus.

A skilled worker in a plant of the Wright Aeronautical Corporation burrs the edges of an aircraft-engine reduction gear.

Flight Technique

Thunderstorms. Robert N. Buck. An explanation of what makes a thunderstorm hazardous also gives advice on the correct method of piloting an airplane through such a storm. The hazards are listed as turbulence, hail, lightning, static, and the pilot's fear. The effect of each of these is discussed and instructions are given for overcoming them. The physiologic effects of a thunderstorm on the pilot are also outlined. *Air Facts*, October, 1943, pages 27–32, 32, 36, 37.

Airways Flying. Capt. J G Cozzens and Bert Moore. It is stated that, from the standpoint of the pilot, flying the airways is perfectly simple, but there is more to it than taking off and keeping going. The writers furnish a simplified account of how it is done. *Air Transport*, September, 1943, pages 39–42, 11 illus.

Transition. II. Wolfgang Langewiesche. In the second article in a series on the technique of flying twin-engined aircraft, the writer explains synchronization of the engines and how to pilot a twin-engined plane with only one engine running. Other factors discussed are the use of the rudder trim tab, single-engined turns, and the need for quick action when one engine suddenly stalls. *Air Facts*, October, 1943, pages 42–48, 1 illus.

Gliding and Soaring

Powdered Gliders. Sky Freighters of the Future. Keith Edgar. A series of comments relating to the predicted use of powered gliders for freight transport after the war The advantages of this type of cargo carrier are specified and certain developments in powered gliders up to the present date are noted. Included in the latter are the detachable engine units developed by the Northwest Aeronautical Corporation of Minneapolis for a standard 15-place military glider. Sketches of the British A.S. 51 Airspeed Horsa illustrate the article. *Canadian Aviation*, September, 1943, pages 52, 53, 78, 4 illus.

Report on Glider Transport. Present . . . Tom Ashley; Future . . . Capt. Edmond L. Brown. This article is divided into two parts, each written by a different person. The first tells of the record long-distance nonstop glider-train flight made by two Douglas C-47's from Shepard Field, Tex., to Laurinburg-Maxton Army Air Base, a distance of 1,243 miles. Carrying extra fuel tanks installed in the cabins, the glider tugs

were loaded to capacity with sundry dead-weight cargo and crews of four men to each craft.

In the other part of the article, the second writer draws a glowing picture of the glider's future cargo possibilities. In addition, his comments touch upon the functions and advantages of the glider, the characteristics of towplanes and the ideal qualifications for a glider pilot. His observations include the prediction that the towplane of tomorrow will be designed especially for that purpose, will probably use Diesel fuel, and will have its tow rope fastened near the center of gravity, so arranged that the rope can be reeled into the cabin upon release of the glider instead of dropping on the airport. Another of his prognostications is that the future glider will have flaps, spoilers, and retractable landing gear. *Southern Flight*, September, 1943, pages 22, 23, 38, 2 illus.

The Horten IV. A comprehensive group of notes on the design, construction, and performance features of a German flying wing (or all-wing), tailless, single-seater glider. Based on an R.T.P. translation supplied by the Ministry of Aircraft Production, this description not only lists the main data relating to the Horten IV glider but also touches on the general problems connected with tailless, all-wing, glider types. An aspect ratio of 21 and three flaps on each wing are indicated as the outstanding characteristics of the Horten IV. Its pilot's compartment permits a kneeling position only. *Flight*, August 5, 1943, pages 139, 140, 2 illus.

History

The Bomber Is Born. A general review of the development of American bombardment policies and bomber designs which conformed with these requirements from the end of World War I to the beginning of World War II. The establishment of the following fundamentals for American air power are noted: (1) long-range—for hemispheric strategy; (2) precision—for an economy of men, planes, and bombs; (3) daylight operations—for visibility; (4) high-level flying—for safety from surface guns; (5) formation missions—for maximum effect; (6) highly trained crews—for economy of effort; (7) fast, well-armored, heavily gunned planes—for independence from supporting aircraft; (8) precision bombsight—for accuracy; (9) all-weather security—for all-weather missions. *Flying*, October, 1943, pages 108–110, 252, 8 illus.

First Ladies of Flight in Canada. Frank H. Ellis. A review of the women who made pioneer flights in Canada. Those whose exploits are mentioned are: Alys McKey, first woman to pilot a plane in the Dominion of Canada; Katherine Stinson, first woman to pilot a plane at any point in the three prairie provinces of Alberta, Saskatchewan, and Manitoba; Ruth Law, first woman to pilot a plane in Eastern Canada; Grace Mackenzie, first Canadian woman to fly as a passenger in an airplane; Olive Stark, first woman airplane passenger in Canada; Dora Labatt, first woman plane passenger in eastern Canada; and Beatrice Mulholland, first woman plane passenger on the Canadian prairies. *Canadian Aviation*, September, 1943, pages 59, 60, 62, 92, 8 illus.

Icing

New Techniques Applied to Anti-Icing Problem. Two recent anti-icing developments are described. The first, conceived and in part elaborated by two engineers of the National Advisory Committee for Aeronautics, is a thermal system which indirectly utilizes engine exhaust gases to preserve a safe minimum temperature on airplane wing and tail leading edges. Adaptations of this anti-icing technique are typified by details on installations in Consolidated Vultee aircraft—the Catalina, Coronado, Liberator, and P4Y-1. Adding no weight to the aircraft, the system is credited with the following advantages: (1) As ice never forms while in flight as long as the anti-icer is operating, there is no danger of it caking and acting as a spoiler; (2) as there is no loss of aerodynamic efficiency in either wing or tail surfaces, the anti-icer can be operated during combat, at slow flying speeds and during take-offs and landings; (3) destruction of accumulated ice and frost begins as soon as the engines of the aircraft are started during subfreezing weather.

The second anti-icing development with which the article is concerned is an electrically conductive rubber strip for keeping propeller-blade edges warm. Perfected by the United States Rubber Company in cooperation with the engineering staff at Wright Field, this device is designed to remove the threat of the loss of balance and of certain airscrew properties of propellers caused by ice formation. Its function is made possible by the use of Uskon—a material which, through the addition of certain chemicals, conducts electricity in contrast to the usual insulating properties of ordinary rubber. *Aero Digest*, September, 1943, pages 225, 227, 267, 4 illus.

Instruments

A Simple CG Determinator. R. G. Worcester. Details are submitted of a device for determining the center of gravity of an airplane. The writer states that it can be manufactured cheaply and requires a minimum of skill to operate. How this device could be used to solve airplane loading problems is outlined. *Aeronautics*, September, 1943, page 37.

Altimeter Setting Indicator. Charles H. Colvin. The paper describes a new instrument, the Altimeter Setting Indicator, developed in the Instrument Division of the Weather Bureau under the direction of the author. The instrument is intended for installation at airports and is a special form of aneroid barometer in which the mechanism is so designed and the scale so graduated that the "altimeter setting number" is read directly. An adjustment is provided for adapting the instrument for use at airports at various elevations above sea level. The paper includes an analysis of the relation between barometric pressure and altimeter setting numbers. The old techniques of determining and making available altimeter setting information are compared with that made possible by the use of the Altimeter Setting Indicator. *Journal of the Aeronautical Sciences*, October, 1943, pages 250–252, 2 illus.

Maintenance

Service Manuals for the Army and Navy Air Forces. A. Lundgren. In addition to outlining the purposes and requirements of service manuals for the U.S. Army and Navy air forces, this article details the procedures involved in producing these manuals. The successive steps of writing, illustrating, and printing such handbooks are related as carried out at Vega Aircraft Corporation. The article also depicts the function and activities of the Army Handbook Branch of the Air Service Command.

Three basic handbooks are described. Required to be furnished to the Government air services 30 days before initial delivery of the equipment, these books are *Erection and Maintenance Instruction*, *Pilot's Handbook*, and *Structural Repair Handbook*. *Aero Digest*, September, 1943, pages, 233, 234, 237, 239, 241, 277, 279, 280, 11 illus.

Check and Double Check. S. A. Green. An improved aircraft maintenance plan developed at Upland Station, Ottawa, by the writer while he was Chief Engineering Officer there is described. It is stated that with this triple-check system airplanes are grounded for much shorter periods. The new system is based on the principle that man power should be concentrated on a few planes to get them into service as soon as possible. The time required to service a plane for a given job is assigned to it; if there are enough mechanics available for only half the airplanes in the shop, they are completed first and others take their turn. Under this system fewer aircraft are in the "unserviceable" category at any one time. *Air Force Review*, September, 1943, pages 6, 7, 22, 4 illus.

Maintenance by Production Methods. H. W. Anderson. The application of production methods to maintenance in the field of air transport is

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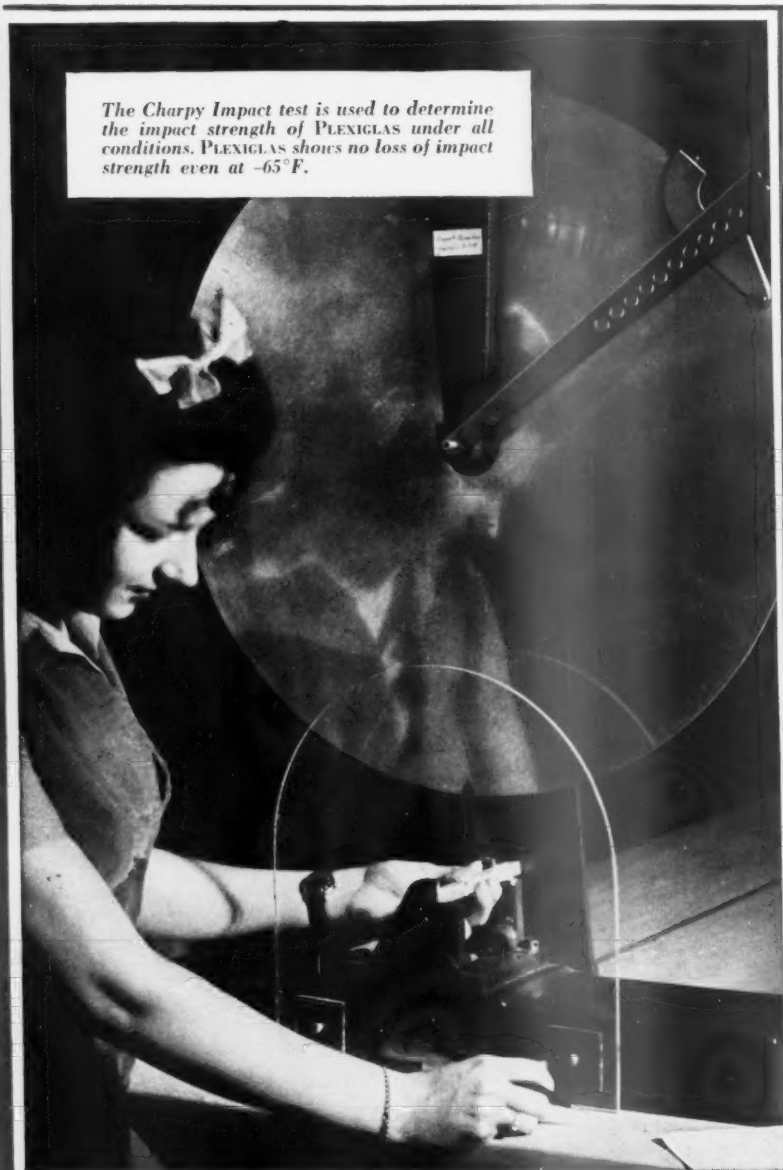

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Let your heart decide

Let your heart decide

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Let your heart decide

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Let your heart decide

Give ONCE for ALL these

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War Prisoners Aid
Belgian War Relief Society
British War Relief Society
French Relief Fund
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Greek War Relief Association
Norwegian Relief
Polish War Relief
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United China Relief
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discussed. It is stated that airlines have had production methods of maintenance of varying degrees in effect for years. They have proved efficient and should be extended to their limit for all possible advantages. How this might be done is discussed. The writer suggests that air lines could benefit by pooling maintenance work. *Air Transport*, September, 1943, pages 51, 55, 57, 58, 4 illus.

Foley Sees Subcontracting of Maintenance. E. J. Foley. The advantages to be gained by the subcontracting of air-line maintenance to service agencies, which promises to be a definite postwar practice, are discussed. Because maintenance is by nature an effective laboratory from which have come many of the refinements incorporated in transport planes, the incorporation of an air-line testing laboratory in this service agency function is suggested. *American Aviation*, September 15, 1943, page 70, 1 illus.

Management

Employe Counseling in Human Engineering. A. C. Galbraith. An account of a new phase of industrial relations conceived at the Douglas Aircraft plant. It is explained that with an organization of the present size of Douglas the individual touch is out of the question. The article describes how a counseling system was developed to represent the President of the company to each employee and to give the employee access to him through the counselor. *Automotive and Aviation Industries*, October 1, 1943, pages 19, 76, 77, 78.

Materials

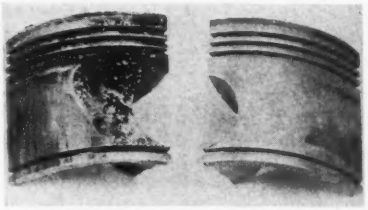
Strength Properties of Red Spruce from West Virginia. F. George Stern. Test data are presented on the strength properties of red spruce according to tests on small specimens cut from six bolts of three trees grown in Pocahontas and Randolph counties, West Virginia.

This red spruce lumber proved to have similar or better strength properties than other spruce and Sitka spruce reported on by the U.S. Forest Products Laboratory.

Because of the shortage of Sitka spruce, Eastern red spruce, similar in physical properties to that from West Virginia, may be of service as a substitute for Sitka spruce for aircraft and other structures. *Bulletin of the Virginia Polytechnic Institute*, August, 1943, pages 3–26, 16 illus.

Medicine

Study of the Effects of Airplane Transportation of 200 Patients. Jan H. Tillisch, John F. Stotler, and Major W. Randolph Lovelace. The effect of air transportation on 200 patients



How Magnus No. 756 solvent cleaner removes carbonized oil is illustrated by this piston section before and after cleaning. (*See* page 171.)

was studied. All of the patients were examined at the Mayo Clinic and a diagnosis was made in each case. Sixty-nine per cent had mild discomfort. It is stated that the generalization can be made that the average sick person can travel by air with safety, the only drawback being that he is more susceptible to airsickness than a well person. There are certain exceptions to this generalization. Patients who have had a recent cranial operation or cerebrospinal puncture should not fly, as a general rule. Patients who have severe cardiac disease or pulmonary disease or who have undergone recent abdominal operation should fly only when absolutely necessary. *The Journal of Aviation Medicine*, August, 1943, pages 162–169, 2 illus.

Effect of Adrenal Cortical Extract on the Altitude Tolerance of Normal and of Adrenalectomized Rats. A. E. Johnson, Morris Eckman, and Bertrand E. Lowenstein. Experiments were conducted in an attempt to investigate more directly the effect of adrenal cortical extract on the altitude tolerance of normal and adrenalectomized rats. The major interest concerned itself with the effect of various doses of such extract on the resistance of normal rats to decreased pressure. The method of conducting the experiments is outlined and the results are set forth and discussed. It is concluded that rats deprived of their adrenal glands have a lessened tolerance for lowered atmospheric pressures. Altitude tolerance is partially restored in adrenalectomized rats by administration of adrenal cortical extract prior to exposure to high altitude.

No influence on altitude tolerance of normal rats could be discovered as a result of the administration of adrenal cortical extract. This was true whether the animals received various doses of extract immediately prior to exposure to decreased atmospheric pressure or for 14 days prior to exposure, as well as during the exposure period. *War Medicine*, September, 1943, pages 318–323.

Steroid Excretion and the Stress of Flying. Gregory Pincus and Hudson Hoagland. It is shown that there is evidence indicating that hormones of the adrenal cortex play a significant role when the organism encounters certain types of stressful situations. Urinary 17-ketosteroids reflect adrenal cortical activity.

Because of the high degree of stress and resulting fatigue experienced by aircraft personnel, it seemed desirable to investigate the output of urinary 17-ketosteroids of aviators when flying and when at rest.

The results of the investigation are reported and summarized. The data obtained are interpreted to indicate that the stimulated and actual stress of flying studied induces adrenal steroid hormone hypersecretion that is reflected in the 17-ketosteroid output; this hypersecretion either causes, or is accompanied by, diuresis.

The Hoagland-Werthessen pursuit meter used in connection with some of the tests is described. *The Journal of Aviation Medicine*, August, 1943, pages 173–193, 13 illus.

Everest Still Stands. Lt. Ken Lester. The physiologic effects of high-altitude flying on pilots are discussed in nontechnical language. The perfected oxygen equipment in use at present is described. *Air Facts*, October, 1943, pages 18–24.

The Organ Weight-Body Weight Ratios in Dogs Following Exposures to Discontinuous Anoxia. Edward J. Van Liere and J. Clifford Stickney. Two groups of dogs were exposed about 8 hours daily, except Sunday, to discontinuous anoxia in a low-pressure chamber. There were minor differences (described fully in the text) in the time and degree of anoxia to which the two groups of animals were subject, but essentially the animals were exposed to a simulated altitude of 18,000 ft. (379-mm. Hg barometric pressure) for a period of three months or more. All of the animals showed a pronounced polycythemia.

It was found that the spleen was significantly enlarged in all the animals. The thyroids were significantly enlarged only in the three animals that were not sacrificed until three months after their exposure to anoxia. None of the animals showed any demonstrable cardiac hypertrophy, nor did any show any adrenal enlargement. *The Journal of Aviation Medicine*, August, 1943, pages 194–199.

So That Man May Fly Higher. Capt. Edward Podolsky. An account of how aviation medicine is conquering the unseen hazards of stratosphere flying. The writer discusses the causes and prevention of high-altitude sickness. *Aircraft Age*, November, 1943, pages 36, 37, 63, 4 illus.

An Interesting Application of a Basic Science to Aviation Medicine. Francis E. Randall and Albert Damon. One of the main difficulties encountered in the designing of oxygen masks is the problem of ascertaining, with a fair amount of certainty, the range in size and proportion of faces which must be properly fitted.

A method of attacking the problem which makes use of the science of physical anthropology is presented. Busts of various types of heads studied in connection with the investigation are illustrated. *The Journal of Aviation Medicine*, August, 1943, pages 200–205, 5 illus.

Factores Psiquicos y Psicopatologicos en los Aviadores. (**Psychic and Psychopathological Factors Which Affect Pilots.**) Juan Garafulic. A medical study of factors that affect pilots as a consequence of the strain imposed upon them by the increased speed, the great flying range, and other improvements of modern airplanes. The writer recommends that fitness tests be made with special care and describes the various phases of these tests. *Revista de la Fuerza Aerea*, April-May-June, 1943, pages 63–67.

Observations on the Results of Indoctrination of Aviation Personnel in the Use of Oxygen Equipment in the Low Pressure Chamber at Pensacola, Florida. Lt. Comdr. H. A. Smedal. The results observed during the indoctrination of almost 6,000 flight students in the low-pressure flight chambers at the U.S. Naval Air Training Center are presented. The procedure is reviewed briefly, and figures are compiled showing the relative occurrence of various physical symptoms and reactions. Failures are classified into four groups and these are outlined. Among the conclusions, it is stated that one indoctrination flight is insufficient to teach adequately the need for the use of oxygen and the operation of the oxygen equipment; that failures result from the lack of frequent lessons; and that more opportunity must be given for the training of personnel in the use of oxygen equipment. It is also shown that supervision must be kept in the hands of the most competent medical officers. *The Journal of Aviation Medicine*, August, 1943, pages 206–210.

Night Blindness of War. Paul H. Wosika. The causes of night blindness are classified and the chemical picture of the night blindness of war is reported. Reports that excellent values for dark adaptation may be found among soldiers complaining of night blindness and vice versa are discussed. The deficiencies of present-day adaptometers are described. A means of differential diagnosis of night blindness and poor adaptation is suggested. *War Medicine*, September, 1943, pages 331–344.

The Treatment of Aero-Otitis Media by Redecompression. Lt. Comdr. H. A. Smedal, Lt. Comdr. H. R. Bierman, and Lt. J. L. Lilienthal. A description of a plan of treatment for relieving aero-otitus media developed during "descent" or recompression in a low-pressure chamber. It is explained that the precipitating event preceding the appearance of aero-otitis media is the development of a relative vacuum within the middle ear. The aim of rational therapy should be the relief of the inequality of pressure.

It is stated that redecompression in a low-pressure chamber has proved to be an effective method of obtaining normal pressure relationships between the middle ear and the environment. In 27 of a group of 33 men with severe aero-otitis media, this form of treatment has effected immediate relief of symptoms and rapid resolution of the process. The failures occurred in patients who, for any reason, were unable to effect or to maintain aeration of the middle ear during and after redecompression. *The Journal Of Aviation Medicine*, August, 1943, pages 211–215.

Present Trends in Teaching at the Army School of Aviation Medicine. Lt. Col. Charles E. Kossmann. Present trends in teaching at the Army School of Aviation Medicine are discussed and the history of the School is briefly reviewed. The principal changes that have occurred in recent teaching methods are described in considerable detail. *The Journal of Aviation Medicine*, August, 1943, pages 216–222.

Metallurgy

Mechanical Properties of Austenitic Stainless Steels. R. A. Lincoln and

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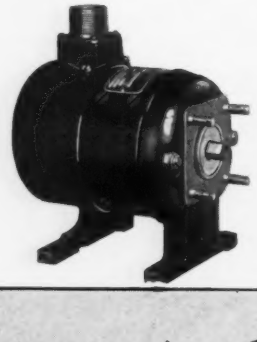

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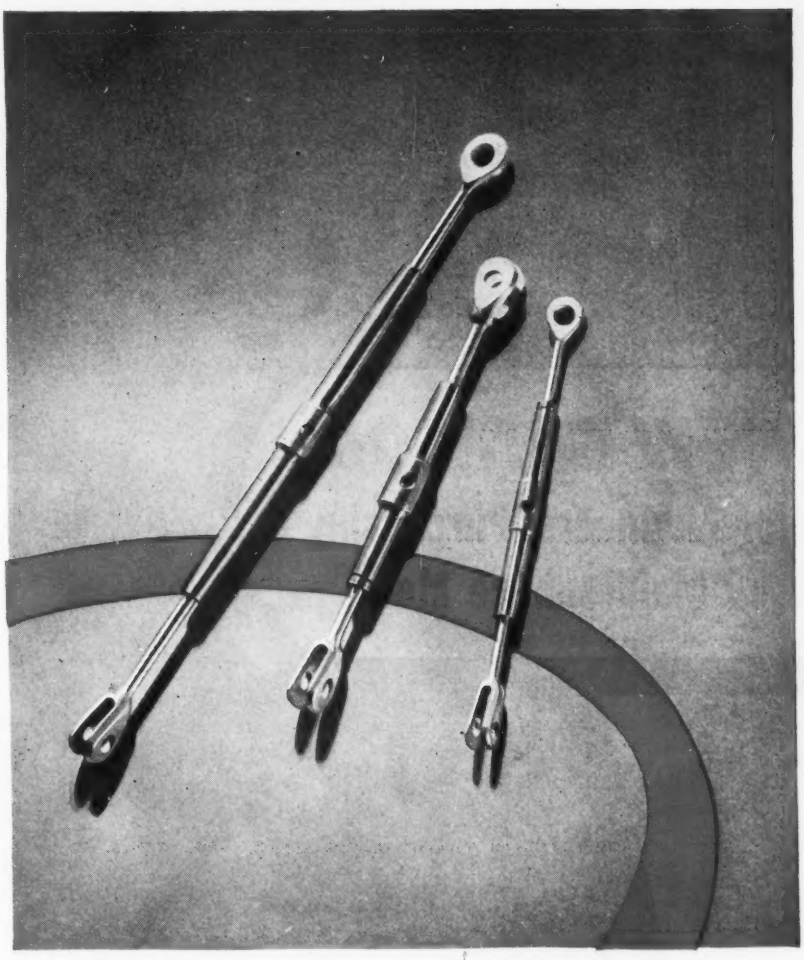

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means Control in the air

W. H. Mather. A study is reported of certain of the mechanical properties of austenitic stainless steels, noting that relatively little has appeared on that subject, whereas considerable attention has been paid to the corrosion and heat-resisting properties of those metals. It is shown that a wide variety of alloys can be obtained by changes in the chemical composition that produce changes in the mechanical properties. These range from a relatively soft metal with a low rate of work hardening which lends itself readily to spinning operations, to alloys that are slightly harder and have a rate of work hardening that make them well suited to drawing and, finally, to alloys that have a high rate of work hardening that can be cold-rolled to extremely high tensile strengths and still have sufficient ductility to allow strip and sheet to be formed into structural shapes.

The writers explain the effects of chemical composition and comment on the control of composition. They then discuss the mechanical properties of annealed alloys with reference to drawing properties, spinning operations, and the production of high-strength alloys. Variation in the chemical composition of the metals is demonstrated as being capable of producing qualities making alloys comparable with the lighter nonferrous metals. Methods of obtaining high mechanical properties and the tests that can be applied are outlined, as well as the specifications that are recommended by the writers. General remarks are made on the effects of different compositions and cold-rolling. Under the heading of fatigue strength, information is given on tests imposed on strip material, with a tabulation of the results. The study concludes with a review of the work done in determining the extent to which manganese can be substituted for nickel. *Journal of the Aeronautical Sciences*, October, 1943, pages 253–260, 272, 4 illus.

Super-Aluminum Alloys for Aircraft Structures. Part II. Kenneth R. Jackman. The second article in a series based on research at the engineering test laboratories of the Consolidated Vultee Aircraft Corporation defines the qualities of the particular kinds of 24S aluminum alloys used as specimens. It describes the heat-treatments applied in aging the material. Results are also shown in the form of graphs and tables.

The importance of both temperature and "time at temperature" is analyzed. The effects of aging and stretching on the tensile and compressive yield strengths of specified Alcoa extrusions and Alclad sheets are given. Points are emphasized on the application of laboratory findings to the production line and on the need for close inspection control, and suggestions for improved rivets for joining the "super-aluminum" alloys are made. Tests on various rivets are described, and the writer recommends the upward revision of present ANC-5 shear allowables for A17ST, 17ST, and 24ST rivets, to give more nearly the typical values found in modern aircraft structures. It is also suggested that consideration be given to the use of 17ST rivets in the "hard" condition to gain a probable shear allowable of 40,000 lbs. per sq.in. and over. *Aviation*, September, 1943, pages 168, 169, 171, 174, 177, 302, 305, 12 illus.

Heat Treating Problems in Aviation. Max E. Tatman. In the aircraft industry the major problem in heat-treating is to increase the weight-strength ratio of the steel, aluminum, and magnesium alloys used in production. In this article the writer describes in detail what is being accomplished in this direction and how the results are being arrived at. *Automotive and Aviation Industries*, October 1, 1943, pages 34, 35, 69, 70, 4 illus.

Metals at High Temperatures. N. A. de Bruyne. The marked dependence of the strength of metals on temperature and on rate of loading at high temperatures can be explained by assuming that above the equicohesive temperature rupture takes place by plastic flow in a nonhomogeneous medium consisting of rigid crystallites weakly cemented together. Although the stress concentrations required by the Griffith theory must still be operative above the equicohesive temperature, it is suggested that they produce intergranular flow rather than the elastic separation that occurs at temperatures below the equicohesive temperature. A theory is developed based on the assumption that the strain energy at rupture reduces the energy of activation of the flow process, and the theory is shown to be in numerical agreement with the experimental results if the energy of activation of the flow process is about one-seventh of the latent heat of evaporation per gram atom. Values of the cohesive strengths and of the stress-concentration factors are also derived. *Aircraft Engineering*, August, 1943, pages 223–226, 5 illus.

The Heat Treatment of Aluminium Alloys. W. L. Morse. The meaning of such terms as annealing, normalizing and age-hardening are defined, and the general principles underlying the heat-treatment of aluminum alloys are discussed. Charts and curves are furnished to clarify the subject. *Aeronautics*, September, 1943, pages 34–36, 8 illus.

Meteorology

Hemispheric Weathermen. William A. M. Burden. The importance of accurate weather forecasting to private industry and commerce as well as military aviation is emphasized by the Special Aviation Assistant to the Secretary of Commerce. He states that every country in the Western Hemisphere is considering the air age of the near future and planning a wider service for its flying citizens. The meteorologic school in Colombia, sponsored by the North American and South American governments, is discussed. It is stated that 200 students from every Latin American country are being trained at the University of Antioquia in Medellin, Colombia. It is predicted that unification of the weather services of the 20 nations may be effected and that better weather services throughout the Americas will result from wartime flying. The importance of radio and other communication facilities is stressed in connection with weather reports. Benefits for postwar private and commercial flying are forecast. *National Aeronautics*, September, 1943, pages 27, 28, 3 illus.

Meteorology and Air Training. Philip Perry. The first of two articles on the importance of meteorology in war and air training. In addition to depicting the role played by meteorology in many phases of war, this installment explains the procedures of weather forecasting. Following an airman through his round of weather observations, the writer describes what he does and the various equipment he uses. The system of posting map signals and plotting lines for weather prediction is then traced. Among the meteorologic factors defined are weather "fronts" and air masses. *Canadian Aviation*, September, 1943, pages 49–51, 101, 6 illus.

Weather. An illustrated article containing general information about the weather. Sections discuss the way the sun's energy keeps the air moving in an endless circulation cycle, types of clouds in the polar-front storm pattern, the dynamic architecture of storms, the part the weather plays in war, and air-mass analysis. *Life*, September 27, 1943, pages 89–103, 41 illus.

How You Can See the Weather Don Romero. An article discussing air currents, "air fronts," and air-mass analysis. How motion pictures are used to teach pilots the way to avoid the dangers of a "cold front" is described. *Popular Science*, November, 1943, pages 90–95, 220, 19 illus.

Corsair SPEED
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Military Aviation

On the Royal Observer Corps. C. G. Grey. An article in praise of the British Royal Observer Corps—the voluntary civil organization that aids the Royal Air Force in spotting enemy aircraft. While outlining the responsibility and importance of the Corps' work, the writer also describes several of the inconveniences with which it contends. These include exposure to inclement weather, difficulties of getting to the posts, inadequate pay and allowances, certain regulations with regard to uniforms, lack of public credit, and insufficient aid from the Air Ministry. A "better deal" is requested for the Royal Observer Corps. *The Aeroplane*, August 20, 1943, pages 209–211, 6 illus.

Lessons from Combat. The functions of the U.S. Army Air Forces' Division of Operations, Commitments, and Requirements are outlined. Charged with assemblage and analysis of performance reports on equipment from the fighting fronts, this division is responsible for recommendations that have resulted in changes in equipment and tactics. The efficacy of their work is illustrated by examples of specific improvements facilitated by the battle reports. *Flying*, October, 1943, pages 76, 77, 354–356, 3 illus.

The History of the Luftwaffe Heavies. H. J. A. Wilson. A discussion of the causes for the apparent decline of the power of the German Luftwaffe gives a lengthy review of the strategy of the first World War, with emphasis on the political aspects of the military policy of that time and the intervening years. It includes remarks on the history of various German military airplanes and their builders, tracing the evolution of current types of heavy bombers. It is concluded that the two principal reasons for the decline of the Luftwaffe were wrong strategic and political conceptions by the German General Staff with regard to the western front and insufficient productive capacity in aircraft and other military equipment to meet the requirements of the eastern front. *Aeronautics*, September, 1943, pages 28–33, 18 illus.

Strategic Bombing. American concepts of air power are explained in this study of the theory, features, procedures, and advantages of strategic bombing. It is shown how the choking of the enemy's mechanized military power at its sources, which is made possible by the long-range bomber, can be used independently to hasten the weakening of enemy resistance and to reduce the ultimate cost of the final assault. A proof of the value of strategic bombing is indicated by Germany's failure to reduce British resistance during the Battle of Britain when, it is pointed out, her limited concepts of air force did not include the employment of scientific target selection and precise placement of bombs.

Illustrated by a chart, the proper sequence of strategic bombing operations preparatory to an invasion is traced through four phases—from the first period of shallow penetration, when bombing is aimed primarily at air defense targets, to the time when land invasion should begin. The article also lists reasons for the use of strategic bombardment, both from the points of view of present economy of life and effort and of our postwar well-being, which will be dependent upon a minimum destruction of the enemy's potential peacetime industry. *Flying*, October, 1943, pages 83–86, 344, 345, 7 illus.

20,000 Bomber Doom over Germany. The question of whether the war could be won overnight with 20,000 bombers in action over Germany is discussed from various angles. It is stated that with this number of bombers out in one night, pressing in wave after wave at a hundred different targets, the enemy's antiaircraft ammunition would gradually become exhausted, even at unhit stations. The enemy fighter planes with their limited time range in the air could not use their full thrust at any given time. They would have to go down to refuel, and fewer would get back each time.

Considering the difficulties of carrying out the idea, it is noted that the plan involves more than 1,600 squadrons of heavy bombers. These it is stated, would require more airfield space than is at present available in the British Isles. Each squadron would have to have a roster of 350 air-force men, in addition to service crews. This presupposes more than half a million air technicians alone. It is concluded that long before the time when such a raid could be staged the Germans will have asked for an armistice. *Aircraft Age*, November, 1943, pages 6–8, 48, 49, 5 illus.

Air Support. This article deals with the organization and operation of those air elements that actually support ground troops. It covers the phase of indirect air support which disrupts enemy lines of communication and supplies and the phase of direct air support that employs airborne guns and bombs to attack enemy concentrations, armor, and troops. As reported, the tactical air force for the latter purpose consists usually of a Fighter Command, a Bomber Command, a Base Service Command, and an Air Support Command that includes reconnaissance functions. The Sicilian, African, and New Guinea campaigns are named as examples of the effectiveness of the air force working in support of and cooperating with land and sea forces. *Flying*, October, 1943, pages 116–118, 3 illus.

New American Weapon. Sam Adkins. An eye-witness account of a glider-borne demonstration, carried out at the Laurinburg-Maxton Army Air Base. To the recital of how the night-and-day demonstrations were carried out successfully there are added a description of the training of air-borne troops and a review of the history of the First Troop Carrier Command, with a list of the senior officers in that section of the Army Air Forces. The functions of airborne troops are outlined. *The American Pilot*, September, 1943, pages 18–21, 32, 6 illus.

German Aircraft in Russia. Cabled by an officer of the Russian air force, this article surveys German aircraft types that have been active in Russia. It is based on an exhibit of captured German airplanes held in Moscow. As demonstrated by these planes, evidence is given of German attempts to improve their models after their first winter in Russia and their initial experience against Soviet airmen. Corresponding changes in German tactics are also reported. Among the modified aircraft mentioned are Messerschmitt Me 109f and 109g, Junkers Ju 87 and 88, Hinkel He 111, Focke-Wulf FW 190 and 200, and the Henschel Hs 129. *The Aeroplane*, August 20, 1943, page 216, 2 illus.

Nerve Center of Air Power. The role played by Wright Field in the development of aviation and American air power is depicted, covering the establishment, functions, organization, military and civilian personnel, activities, and achievements of this Army Air Forces' field laboratory and scientific institution. As described, Wright Field's job is to develop advanced aircraft auxiliary equipment and accessories for use by the Army Air Forces, to procure equipment and accessories for issue to the various Air Forces' units, and to test the worth of all experimental types of aeronautic equipment. Several developments fostered by Wright Field are mentioned, and it is related how the men of Wright Field pioneered in flying higher, farther, faster, and blind. Duties of Matériel Command and its three separate operating divisions—Engineering, Procurement, and Production—are particularized. *Flying*, October, 1943, pages 122–125, 304, 6 illus.; "Quick and Dirty," Paul Gallico, *Saturday Evening Post*, October 9, 1943, pages 9, 10, 37, 38, 40, 3 illus.

Will Gliders Replace Paratroopers? W. Austin Campbell. Advantages of the glider for troop transport are described. It is stated that the effectiveness of paratroops is now greatly enhanced when glider troops are used to support them. Gliders have proved a surprisingly effective means of placing troops on the ground behind enemy lines. According to enthusiasts, glider troops can be used to bet-

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ter advantage than parachute troops 95 per cent of the time. *The American Pilot*, September, 1943, pages 22, 30, 1 illus.

Naval Aviation

Shipborne Air Power. A discussion of the relation of land-based and ship-borne air power. While offering observations in defense of carrier-based planes, the writer admits that, with the development of greater range for aircraft, the sphere of the aircraft carrier may become more limited. His conclusion is that versatility is highly desirable and that Great Britain should build up a powerful and closely knit combination of air and sea power in addition to her great Navy and her specialized land-based and sea air forces.

Stressing particularly the value of carrier-based planes as a defense medium for naval vessels and merchant convoys, the writer answers a number of statements made by a U.S. Congressman, Melvin J. Maas, in reference to sea-borne air power and aircraft carriers. There are three main points, which are contested, of Representative Maas's thesis: (1) There should be increasing emphasis on landplane development with the resultant decreasing dependence on the aircraft carrier. (2) The day of the seaborne airplane is past, since the carrier aircraft cannot compete with land-based aircraft because of the inherent technical limitations. (3) Therefore, the utility of the aircraft carrier is diminishing, for the carrier—as a fighting ship and as a mobile landing field—has been demonstrated in this war to be too vulnerable. One major argument in the refutation is that as long as the torpedo remains a lethal weapon, there will be a necessity for the smaller and more highly maneuverable airplane working from a mobile base. *The Aeroplane*, September 3, 1943, pages 267–269, 3 illus.

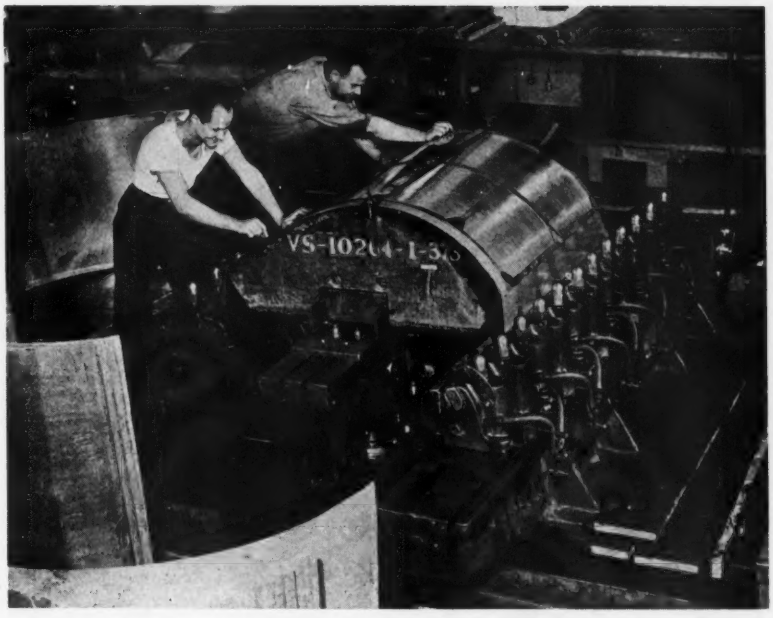
Paints and Coatings

Engineering Fundamentals of Aircraft Finishes. A. L. Johnson and John D. Oudhoff. The physical characteristics of the materials used in protective coatings and finishing systems for aircraft are discussed. Wood finishing is considered first, beginning with the kinds of wood, their respective natures, and the types of finishes to be used on them. Resinous-bonded plywood, consisting of mahogany, birch, gum, fir, or spruce, is generally employed. Properties required of the wood are outlined, as well as the treatment to which the material is subjected, including the filler, sealer, and surfacer.

Fabric finishes and the problems they present are next considered, with reference to the finishing materials, or dope—composed of cellulose derivatives, plasticizers, and volatile matter—and their properties. Equipment used in determining the viscosity of the dope is described, and instructions are given for applying the finish to the fabric. The use of heat permits the application of more solids per coating operation. The merits of aircraft finishes formulated with cellulose acetate, cellulose acetate butyrate, and nitrocellulose are compared, and comments are made on fabric-covered plywood, which is called a combination of the two systems under consideration. Discussion follows of the reasons for some of the common troubles encountered in the finishing of fabric and remedies for them.

Referring to the application of organic coatings to metals, it is stated that the prime factor of importance is that of adhesion. Details are given on the surface qualities of various aircraft metals and the steps taken in protecting and finishing them. Tests are suggested for the priming materials, and information is given on lacquers and enamels for final coatings. *Aero Digest*, September, 1943, pages 159, 160, 165, 166, 173, 175, 249, 15 illus.

Chemical Surface Treatment for Steel. F. Carl Hirdler, Jr. Inorganic chemical surface treatments for steel, which may be classified as oxide or phosphate types, are considered. Electroplating is not included as a chemical treatment because of its electrical nature. Organic paint coatings are discussed as secondary, rather than primary, coatings. The oxide and phosphate methods of coating steel are described and the advantages and disadvantages of each are outlined. A drying type oil finish to be applied over phosphate coatings, recently developed by a Los Angeles paint company working in conjunction with a process engineer from an aircraft company, is referred to. It is stated that in order to conserve stainless steel and aluminum wherever possible, aircraft companies are using phosphate-coated and painted low-alloy steel parts in many cases. Where good abrasion resistance is essential, however, as for landing gear assemblies, phosphate coating is not practical. *Automotive and Aviation Industries*, September 15, 1943, pages 18–20, 84, 1 illus.



A plastic stretch-press mold saves time and cost in the production of Corsair fighters at Brewster Aeronautical Corporation.

Personalities

British Builders in Profile. Keith Ayling. Biographic sketches of the men responsible for some of England's outstanding aircraft. The writer describes the activities of Handley-Page, A. V. Roe, Oswald Short, and C. R. Fairey. *Air Trails*, October, 1943, pages 32, 70, 72, 76, 3 illus.

America's #1 Eagle •••• Walter McCallum. Although this article on Gen. Henry H. Arnold includes a characterization of the Commanding General of the Army Air Forces and biographic data on the important events in his life, it is mainly concerned with his interpretations of air power which have helped to develop American principles of air combat. His sponsorship of the long-range heavy bomber, strategic bombing, and an independent air arm is related, as well as his belief in the value of pursuit aviation, auxiliary arms, and low-altitude horizontal bombing. *Skyways*, October, 1943, pages 28, 29, 56, 86, 88, 4 illus.

Packard Aircraft Electric Cable

Up where the air is thin and cold, the problem of safeguarding the surge of electricity that "sparks" engine performance is intensified many times. It has been one of Packard Electric's assignments to develop ignition cable for high-altitude operation, and this Packard cable is now serving in bombers and fighters of America's air forces. Close cooperation with the air forces, aircraft manufacturers and airlines has enabled Packard Electric to apply the full measure of its experience to meeting the requirements of the aircraft industry. Many types of Packard aircraft electric cable are performing varied functions on airborne equipment.

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Personnel

"Victory Shift" Helps Ease Labor Shortage. A new system of employing part-time workers which has been instituted by Bell Aircraft Corporation is outlined. Instead of the usual 4-hour part-time shifts, this plan calls for the employee to work three full consecutive days of each week, with two workers assigned to each job. Advantages of part-time work on this schedule instead of the 4-hour shifts are summarized. The article also relates how Bell Aircraft recruited employees for this program. *Wings*, September, 1943, pages 653-656, 6 illus.

The Men. This article treats of the importance of the Army Air Forces' classification program in efficiently procuring, placing, and training men for the 450 different Army Air Forces' occupations. It also touches upon some of the general problems that were involved in the expansion of the Air Forces from an organization of about 145,000 men to one of 2,200,000. Four guiding principles of A.A.F. personnel policy are outlined: (1) Try to place a man in the most valuable job for which he is fitted. (2) Put the power to classify and reclassify in the hands of trained personnel officers. (3) Promote men on the basis of ability, not formula. (4) Educate men for better jobs through the technical training program. *Flying*, October, 1943, pages 114, 115, 236, 4 illus.

Photography

Air Photography. Air Com. J. L. Vachell. The extent to which aerial photography is employed by the Royal Air Force for military purposes is indicated, and developments in equipment are reviewed. The following are noted among the applications of air photography: for recording air combat, reconnaissance, ascertaining bombing damage to enemy territory, training purposes, and study of enemy objectives preparatory to bombing missions. It is reported that the greatest photographic development made since the beginning of the war has been in night photography. The article also includes the comment that, despite the reputed excellence of their cameras for ground purposes, the Germans are backward in the development of air photography for military uses. *The Aeroplane*, August 20, 1943, pages 214, 215, 7 illus.

Plastics and Plywood

Omni-Directional Pressure in Flexible Bag Molding of Curved Plywood. Thomas D. Perry. The application of the so-called rubber bag process to the production of compound curved plywood involving simultaneous bonding and forming is credited with having made possible the use of plywood

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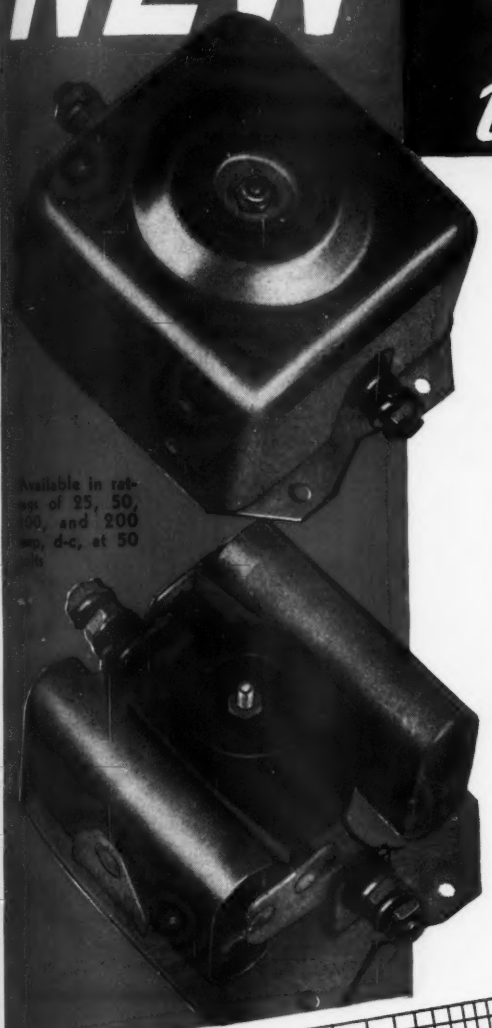

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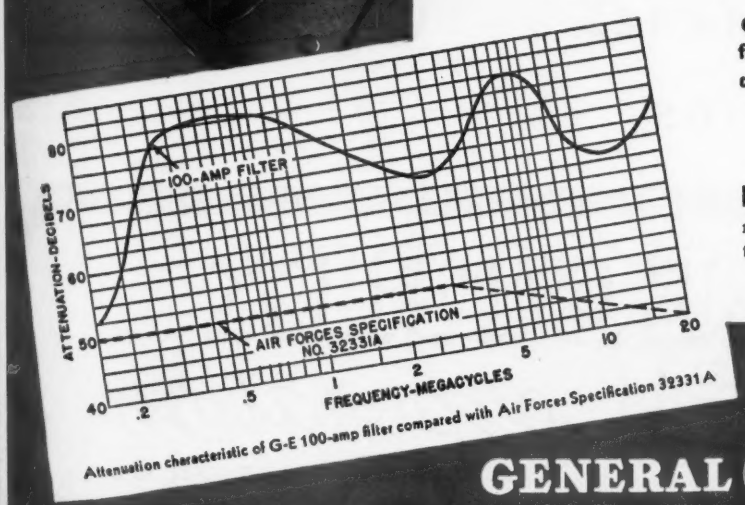

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The starboard half of the forward section of an airplane fuselage is removed from the mandrel after bonding at the plant of Cockshutt Moulded Aircraft in Canada.

where it had not previously been usable. A notable example given is the "plywood" airplane. Three of the principal methods of making monocoque plywood with flexible pressure bags are classified as: (1) inflatable closed bag, or mattress, applied to but not enclosing the plywood assembly; (2) deflatable open-end bag enclosing the plywood assembly; and (3) deflatable half-bag, or blanket enclosing the plywood, in which the mold constitutes the other half of the bag.

Each of these three methods is explained in simple terms showing how the process is carried out, with sketches illustrating the operations and equipment. A comparison is drawn of the third method with the other two, noting that the mold is concave rather than convex, giving the outer side a smooth surface. Another advantage cited is that the heat is applied to both sides of the plywood, shortening the curing cycles and facilitating the penetration of the heat. Effective pressure and ineffective pressure are defined, and instructions are given for making assemblies of varying thicknesses.

The special requirements for adhesives in bag molding are outlined as follows: (1) Adhesive bond must be accomplished in minimum time. (2) Low temperatures are desirable to lengthen bag life. (3) Relatively long "flow" periods are important to allow slippage of layers into final position. (4) Long assembly times are imperative to prevent the adhesive becoming tacky during the long wrapping operation. (5) Veneer to be curved should be as ductile as possible to eliminate rupture or excessive stresses in bending. The three types of thermosetting resin adhesives are outlined, with remarks on the third type, a fortified urea-formaldehyde resin. *Commercial Aviation*, August, 1943, pages 114–116, 4 illus.

Thermoelastic Forming of Airplane Parts. W. I. Beach. A description of the North American Aviation thermoelastic forming process and how it was developed. So-called finally cured, or "C" stage, phenolic laminated-fabric-base sheet is treated by this process. The writer discusses the forming characteristics of thermosetting sheets, the relative forming capabilities of aluminum and laminated plastics, and the sphere of application for plastics. *Mechanical Engineering*, October, 1943, pages 719–723, 10 illus.

Pilot's Plastics Seat. A description of the properties and applications of Aeroplastic, a synthetic material used for the pilot's seat in Spitfire fighter planes. The article includes data on the molding technique for this laminated plastic and also on the construction of the Spitfire seat. With a paper base and possessing a tensile strength of 26,000 lbs. per sq.in. in its flat state, Aeroplastic is claimed to have the highest combined figures for tension, impact, and shear strength of all laminated plastic materials thus far produced on a commercial basis. *Aircraft Production*, September, 1943, pages 429, 430, 3 illus.

Fiberglas Reinforced Plastics. Tyler Stewart Rogers. The wood industry in the past several years has adopted the use of synthetic resins as adhesives, molding processes to form compound sections rapidly, and heat developed by high-frequency radiation of electrical power to accelerate the process of wood fabrication.

The use of the high-frequency radiation machine in the production of cargo-carrying glider parts manufactured by the piano firm of Steinway and Sons is described. It is stated that wood fabrication using synthetic resin glues has been immeasurably advanced by the use of high-frequency heating. Basic advantages of high-frequency heating are outlined. One of these is the ability to heat the complete mass of material throughout. It is explained that the most important use of the high-frequency machine is to speed up the production of fabricated wood by decreasing the time required to glue joints. *Modern Plastics*, September, 1943, 88, 140, 142, 3 illus.

Plywood and Plastics—III. W. Nichols. The third article of this series covers basic design factors and stress data for plywood structures. It compares the tangential and radial shrinkage of various woods and offers a lengthy study of moisture content, clarified by numerous charts and tables. It is explained that the problem of moisture resistance and dimensional stability is being attacked from two standpoints—the first involving the use of protective coatings on finished surfaces, and the second involving the impregnation of the veneers. A third method, stated to be requisite for veneers of $^1/_{16}$-in. thickness or greater, calls for the application of the resin under vacuum pressure. A simple rule is offered for determining glue spread.

A discussion follows of an investigation by the Air Ministry of a plywood fuselage supplied by Aero Research, Ltd., for a study of the deflections under bending and torsional loads. Formulas and curves resulting from these tests are explained, and recent developments in molded plywood construction are considered. A method is worked out for the determination of allowable tension and compression stresses for the veneers in a panel. *Flight*, August 5, 1943, pages 150–154, 10 illus.

Plywood and Plastics—IV. W. Nichols. The concluding installment of this series carries on the study of the molded plywood fuselage, with reference to the effects of grain angle and stress analysis. Balanced construction is held to be necessary, and is defined as construction in which the veneers are symmetrically located about the centerline of the panel with respect to thickness, grain direction, and species. Advice is given for arranging the veneers in the most desirable manner to accommodate the predominating stress. A method is developed for determining the effective width which varies with the stringer stress and also requires evaluation of the effect of the curvature of the panel.

The relationship of grain angle to tensile strength is investigated, and a

method is offered for calculating tension stress claimed by the writer to have the advantage of predicting failures within 10 per cent. A formula is given for the calculation of the permissible shear load on a panel. The series concludes with a description of a recent development called the Plasti-Ply process, which is stated to incorporate all the advantages of molded plywood construction and involves an integral girder or geodetic structure. *Flight*, August 12, 1943, pages 174–175, 3 illus.

Problems in Wood Aircraft. Ivar C. Peterson. Certain peculiarities of wood that must be taken into consideration by the aircraft engineer if he is to design structures that make full use of the benefits to be derived from wood are studied.

It is stated that attempts to take advantage of the high tensile strength of wood will lead to failures in shear because loads, theoretically in tension, practically always have shear components that are great enough to overcome the low shear strength of wood. Moisture content also has a great effect on the strength of wood, and the moisture equilibrium of a piece of wood will vary with the relative humidity and temperature to which it is exposed.

Some of the problems confronting the wood aircraft manufacturers are discussed under sections dealing with fabrication, static testing, and detail design. *S.A.E. Journal*, October, 1943, pages 369–380 (Transactions), 8 illus.

Postwar Aviation

What the Postwar Buyer Wants. J. H. Geisse. The writer suggests improvements in planes and facilities which he deems necessary to create and sustain the potential market for postwar private airplanes. Several of the refinements are indicated by surveys of why only about 15 per cent of the people who tried flying continued to keep at it before the war. These surveys show the cost of private flying to be the prime reason, the inaccessibility of airports the second, and the private plane's lack of utility the third. In addition to advice on how these three complaints may be met, the writer also discusses the importance of making the airplane safer, more comfortable, and simpler to control. *Aviation*, September, 1943, pages 116, 117, 312, 313, 314, 3 illus.

The Economics of Post-War Carriage of Air Cargo. J. V. Sheehan. It is declared that in the postwar period, lower costs on transport of higher classes of surface freight and express through better planned equipment will be of paramount importance. Replies from a recent air-line survey show that 83 per cent of the carriers favor cargo-carrying facilities in passenger planes for the postwar period, particularly for transcontinental and transoceanic operation and even for feeder-line service. For the lowest ton-mile costs, however, exclusive cargo planes are the ultimate goal. Larger combination planes, for the time being, will doubtless prove most practical during the initial stages of domestic cargo development.

Curves and charts showing the effect on ton-mile costs of different-size planes with varying power units emphasize the principle that the largest airplane operates at the lowest ton-mile cost. The point is stressed that speed is another governing factor in cargo haulage. Where speed is of major importance, twin-engined planes are most efficient. A governing factor on four-engined ships is take-off weight, which must be limited so that Civil Air Regulations landing weight is not exceeded for short ranges.

The twin-engined plane has its best advantage under 250 miles, and beyond that figure four-engined plane efficiency improves. At ranges of 500 miles, it is shown that, on a four-engined plane, a 20-mile difference in speed affected operating costs about 5 cents per ton-mile, and on a two-engined plane the same speed differential causes a cost differential of about 2 cents per ton-mile. Twin-engined planes are the most economical if size of pay load does not exceed the capacity of the largest twin power plants available. *S.A.E. Journal*, October, 1943, pages 362–368 (Transactions), 7 illus.

An Air Union for Action. For concerted action on the part of the aircraft industry in dealing with peacetime problems and protecting itself, an actual union of all concerned groups is urged. It is suggested that this Air Union be constituted by and formed out of all existing air associations, chambers of commerce, institutes, and similar organizations, supplemented by individual membership open to anyone interested in aviation. The peacetime problems cited as the most apparent are those relating to: (1) retention of autonomy; (2) aircraft as the first line of defense; (3) adoption of latest technical improvements; (4) equitable provisions for foreign routes for air transport companies capable of operating them. *Aero Digest*, September, 1943, page 148.

How Practical Are Polar Routes? Glen Ingles. An investigation of some of the economic and meteorologic factors that will affect postwar international air routes. It is demonstrated that, although the polar route may be most advantageous from a straight-line-distance point of view, other considerations may cause the flight patterns of world air lines to deviate from the great circle route. Among those mentioned are: traffic opportunities, fuel, accommodations for comfort, weather, climate, and short-haul business. *Western Flying*, September, 1943, pages 49, 100, 102, 2 illus.

Short Haul Transports. Charles Froesch. Basic specifications are suggested for postwar short-haul cargo-passenger planes of high efficiency and low operating cost. The writer discusses the general requirements for such a plane; the passenger, baggage, and cargo provisions; and performance requirements. *Air Transport*, September, 1943, pages 32–35, 4 illus.

The Empire and the Air Age. W. Hudson Fysh. In a few brief comments the Managing Director of Australia's air transport company, QANTAS, stresses the need for strong Empire air communications after the war. Urging a "true partnership" between the United States and the British Empire in the interest of world peace, he designates air parity as an essential prerequisite. *Flight*, August 12, 1943, page 170.

Somebody Build Me This One! Charles E. Planck. In an article written in a somewhat humorous vein the writer suggests the specifications for a postwar airplane for the family. *Air Trails*, October, 1943, pages 22, 23, 76, 3 illus.

Headache with Wings. Boyden Sparkes. Plans of the aircraft industry for obtaining work after the war to utilize their greatly expanded facilities and personnel are discussed. Reporting on the great numbers of people now employed by the aircraft manufacturers and the expected decrease that will accompany the cessation of war, the writer explains some of the problems of the industry in combating this condition. Tax inequities and the need for postwar financial reserves are explained.

A list is given of the possible non-aviation applications for their experience and facilities which are being investigated by aircraft manufacturers. The probable directions in which wartime labor will be syphoned to peacetime phases of the industry are also indicated. It is believed that the fields of air transport and private flying will absorb a great proportion. *Saturday Evening Post*, September 18, 1943, pages 26, 27, 82, 85, 87, 4 illus.

Control or Competition? Dealing with postwar air transport, this article contains, first, a brief summary of the salient points in the report of a committee that consisted of four members of the British Parliament. Although the full text of the report is stated to include suggestions on other phases of postwar aviation, the recommendations outlined pertain mainly to the establishment of an Empire Air Board and to a proposed international convention.

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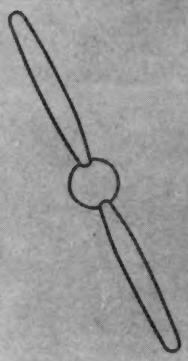

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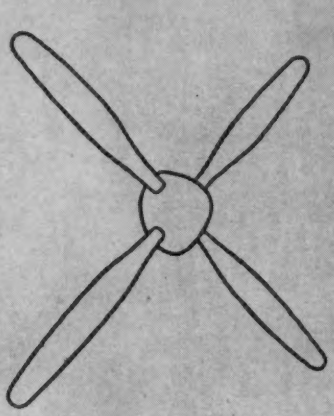

3. The FOUR-BLADE AEROPROP, like its three-blade partner, is versatile, operating either with or without a cannon in its hollow hub. Like all Aeroprops, its pitch action is fully automatic, with the power for pitch changes self-contained in the compact propeller assembly.

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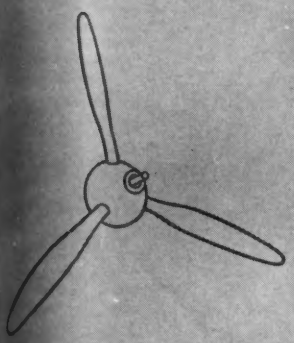

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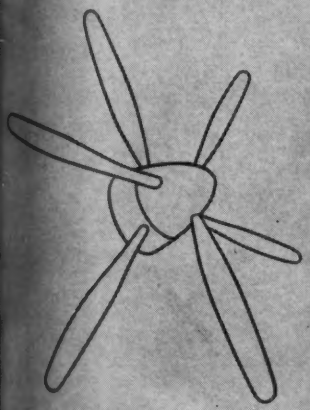

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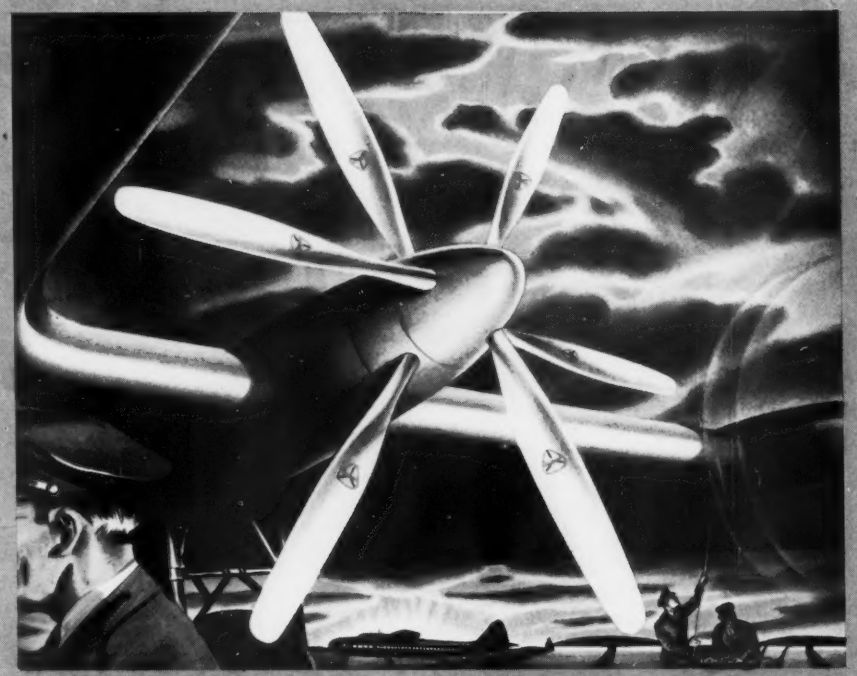

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The second part of the article is concerned with a statement of the Joint Air Transport Committee—representing the Association of British Chambers of Commerce, the Federation of British Industries, and the London Chamber of Commerce. This statement commented upon two statements of policy issued by the United States air lines—the first supported by 16 air lines; the second advanced by Pan-American Airways, American Export Airlines, and United Airlines. *Flight*, August 19, 1943, pages 206, 207, 1 illus.

Aviation's Three Bogies. Harry Woodhead. The President of Consolidated Vultee points out that progress in postwar aircraft building depends on the solution of three problems: production, renegotiation, and legislation. Present and future production problems are discussed. It is explained that more than a year must elapse between the first drawing and the production stages of a new type of airplane of medium size. It is stated a 400-passenger plane is now in the mockup stage, but it will require two years before it is ready for flight. The task of putting a plane of this size into quantity production is pictured. *Air Trails*, October, 1943, pages 15, 16, 82, 84, 85, 86, 4 illus.

Legislation for Postwar. Major A. L. Bulwinkle. It is predicted that past achievements in the development of air transportation, which have required the combined efforts of government and industry, will be far surpassed by those of the future. A bill introduced by Congressman Lea to revise civil aviation legislation in preparation for the postwar period of growth is referred to. The proposals in the pending bill, which are of particular importance to the future of aviation, are outlined and discussed. *Air Transport*, September, 1943, pages 36–38, 1 illus.

Post War Jobs for War Planes. Russ Brinkley. In informal style, the writer investigates the possibilities of conversion to peacetime uses of some of the surplus military aircraft at the end of the war. Starting with the twin-engined advanced trainers, such as the Cessna, the Beechcraft, and others, it is shown that these can be used for transporting business executives, for fast delivery of merchandise, for aerial photography and exploration, for scientific studies in the upper air, and for broadcasting and radio experimental work. Another suggested use is for shuttle services to and from airports and for short cross-country charter service or other special missions. Amphibian planes are suggested for such work as rapid transportation of fishery products to market.

For larger aircraft, it is indicated that the movement of frozen foods and perishable fruits and vegetables will provide an important field, and it has even been suggested that

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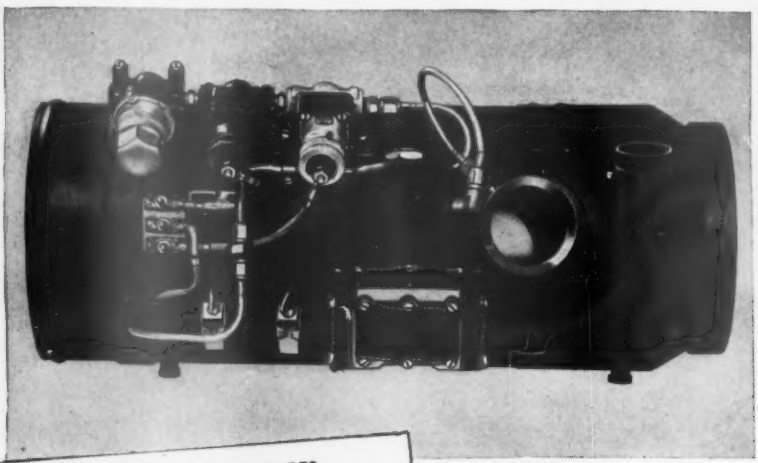

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Serial 101

PERFORMANCE RUNS...CONSTANT FUEL PRESSURE WITH VARIOUS COMBUSTION-AIR PRESSURES

Type 906A

COLD-START TESTS

Type 906A

COLD START TESTS AT ALTITUDE

Type 906-A
Serial 101

Pressure Altitude, Ft.	Inlet Air Temp. °F	Combustion Air Pressure "H_2O ★	Fuel Rate #/Min.	Time to Start
20,000	- 65	5.5	0.076	25 SEC.
25,000	-70	6.7	0.078	3 MIN 25 SEC
25,000	- 68	6.7	0.078	2 " 38 "
25,000	- 54	7.2	0.082	1 " 55 "
25,000	- 50	33.0	0.081	2 " 55 "

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Model 905 weighs only 7½ pounds. Continuous operation—by blower on the ground and ram-air aloft—is attained by addition of fan. Switch-over is automatic. Actual test data is shown below.

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Type 905
Serial X566

PERFORMANCE RUNS AT HIGH ALTITUDE

Type 905
Serial X566

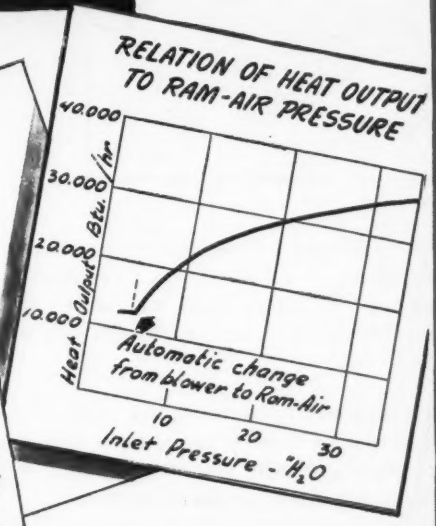
COLD-START TESTS AT ALTITUDE

COLD START TESTS

Type 905
Serial X566

Cold Room Temperature	Voltage at Heater	Inlet Pressure "H_2O	Time to Start
	24.0	2.9	4 MIN 10 SEC.
-64	24.0	6.0	2 MIN 10 SEC.
-62	23.0	2.8	NO START *
-58	24.0	2.8	30 SEC.
-40	24.0	2.8	3 MIN 10 SEC.
-40.			

★ NOTE LOW VOLTAGE



Note how automatic maintenance of fuel-air ratio results in increased output as ram-air pressure increases.

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2. Unique spring design provides high contact pressure within small space limits.

3. Twin contacts provide added assurance of reliability.

4. Newly designed pin-pivoted armature with full-length bearing results in exceptionally long life, even under the toughest conditions.

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high-altitude airplanes can be used instead of refrigerating machinery for the quick-freezing of perishable foods, by transporting them rapidly into the subfreezing temperatures found in the higher air. Similarly, larger airplanes are suggested as suitable for flying laboratories. Present-day bombers could be employed for the transportation of moderately heavy and bulky freight. *Flying Aces*, October, 1943, pages 29, 68, 69, 3 illus.

We'll Have to SELL Airplanes Again. Caden Jenkins. A discussion of some of the marketing problems that will confront the aviation industry after the war. In analyzing a few of the conditions affecting the postwar sale of airplanes, the writer considers the high taxes that will decrease the incomes of individuals and corporations, the length of time necessary to reconvert a war plant to the manufacture of a peacetime product, the unknown quantity of Government control, and such factors as foreign exchange, favorable trade balances, etc. Among specific problems that will have to be met by airplane marketers he mentions the development of sales through advertising and promotional programs, trade-in allowances and financing, and the question of whether the manufacturer is going to specialize in large or small airplanes. *Western Flying*, September, 1943, pages 62, 116, 118, 1 illus.

Facing Norway's Future. Capt. A. Roy Brown. In an interview with Lt. Col. Ole Reistad, the Commanding Officer, in Canada, of the Royal Norwegian Air Force is questioned with regard to the future of aviation development in Norway. His observations indicate the expectation that the fighting air force being trained in Canada today will form an efficient nucleus for a peacetime aviation industry in Norway tomorrow. He also predicts a continuation of the system of air instruction that was in practice in Norway before the war. This system coordinated, in progressive stages, model building, glider training, and aircraft training. *Canadian Aviation*, September, 1943, pages 54, 55, 104, 9 illus.

Postwar Airways. Allen Scott. The first of a series of articles on airways of the future. The writer discusses ultra-high-frequency radio. He states that radio development of components and major apparatus indicates beyond any doubt the early transition of present airway radio navigation and communication facilities from the currently used low and medium-high frequencies, respectively, to the ultra-high frequencies above 100 megacycles. It is indicated that this transition will bring about greatly improved navigation and communication because of more favorable wave propagation characteristics and the absence of "static" effects. Aircraft antennas will be more favorable from the aerodynamic point of view. Operation will be much more efficient from the pilot's point of view. *Air Transport*, September, 1943, pages 63, 64, 66, 1 illus.

Production

Aircraft Electrical Wiring. Features of the Oddie System of aircraft wiring installation are examined. Employed on both bomber and fighter airplanes, this system is credited with low weight and a method of assembly which permits modifications to be made with a minimum of difficulty. Cable harnesses are built up as subassemblies to suit the aircraft layout, standard single-core cable being used as far as is practicable. Lengths of polyvinyl-chloride tubing are slipped over the cable assemblies to hold and support the leads. Installation of the harness involves attaching the connectors at the ends of the cables and inserting retaining pins through the harness into clips riveted to the aircraft structure. *Aircraft Production*, September, 1943, page 454, 3 illus.

Air Conditioning Helps Production in Many Ways. L. W. Clifford. Several methods by which aircraft production are facilitated through the use of air conditioning and refrigeration are described. Among the applications noted are the control of temperatures in gauge rooms, the refrigeration of baths used in electroplating and anodizing, the air conditioning of rooms where metallurgic analysis is carried out by means of the spectroscope, the chilling of tips employed in spot welding, the air conditioning of dope and drying rooms, and the storing of aluminum rivets at sub-zero temperature levels. In addition, the use of air conditioning is noted for various circumstances and equipment affecting the pilot. *Aero Digest*, September, 1943, pages 217, 219, 5 illus.

Salvaging Aircraft Structures in Process of Manufacture. R. L. Schleicher. The salvaging of air frames during the process of manufacture is discussed. The writer explains how the war has increased the importance of salvaging parts and has placed greater responsibility on the small group of engineers and inspectors who, in every plant, must keep a constant vigil to maintain a high standard of quality and serviceability. The ten laws that may be termed the "constitution" of the salvage inspector are listed. The subject is discussed under sections covering the responsibilities of the manufacturing, inspection, and engineering departments; analysis of damage; steel tubing repairs; the salvaging of machine parts; sheet metal repairs; rivets and riveting; stringer repairs; and bolted joints. It is emphasized that each detail is a necessary part of a complete assembly and that upon these details depends the success or failure of an assigned mission. *Mechanical Engineering*, October, 1943, pages 711–718, 7 illus.

Capitalizing "Know How" in Subcontracting. Herbert J. Woodall. The President of the company tells how Woodall Industries applied its experience in fabricting cardboard products for automobile manufacturers to subcontracting air-frame parts and the fabrication of sheet aluminum. In describing the production processes, he notes particularly the following features: the flexible production control system, the use of "rule dies" for blanking, the cutting of aluminum on an embossing press, assembly operations, and the hauling away of airplane parts in trailers. *Wings*, September, 1943, pages 657–661, 12 illus.

A Change in "Cornell" Release Bracket. E. E. Elliott. A change in a "Cornell" Release Bracket, No. 68450, to a new part, No. 18450, is noted. Pointing out the features of the redesign, the writer also designates the advantages resulting from it. *Commercial Aviation*, August, 1943, pages 68, 72.

Gravity Diecasting. Part I. First of two articles dealing with the gravity die-casting foundry installed at one of the Rolls-Royce shadow factories. In addition to surveying the organization of the foundry, Part I describes in detail the various types of dies used for Merlin engine components and the methods of casting them. Advantages of die-cast parts over similar parts made by ordinary sand-casting methods are summarized.

The study begins by following the process through die development, die design, the die drawing office, and the experimental die foundry. It then illustrates the work involved by detailing the production techniques and general points of interest in connection with several different representative types of dies. These include dies for the front gear case cover (with specific attention paid to shrinkage), coolant pump casings, boost control casings (with notes on top pouring), rocker covers, cover plate and guide, coolant inlet, and cylinder skirts. Other parts of the article are devoted to discussion of the design of the die base, die heating, X-ray examination, and detection of faulty technique. *Aircraft Production*, September, 1943, pages 434–442, 19 illus.

Lord Plant Organized Efficiently to Make Wide Variety of Rubber Mountings for Vibration Control. Joseph Geschelin. The production of bonded rubber shear-type mountings for aircraft and general industrial applications, as carried out by the Lord Manufacturing Company, is

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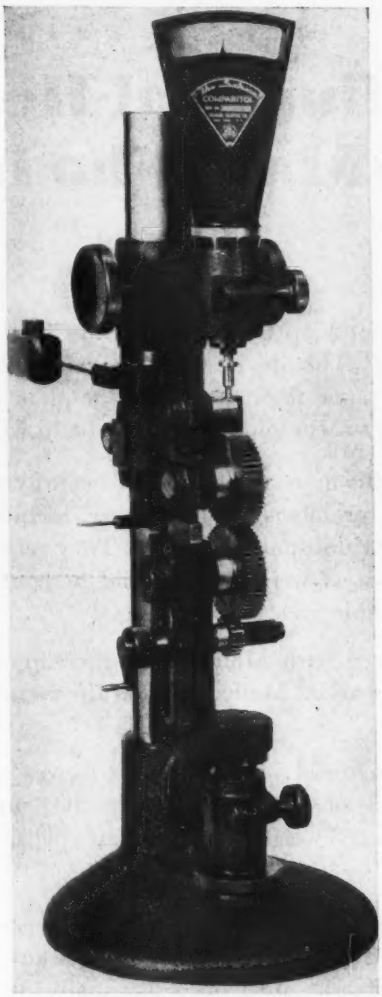
described. One of the most recent developments in vibration control is the introduction of "Dynafocal" suspension for radial aircraft engines in which the mounting is so arranged as to act through the center of gravity of the engine system. *Automotive and Aviation Industries*, October 1, 1943, pages 20–24, 94, 12 illus.

No More Cadavers. Sidney Swirsky. Outlining the spare parts production program, this article relates how it has resulted in a greater number of flying hours and a lesser number of discarded planes. It traces the development of spare-parts production to the industry plan now in operation—where spares are manufactured and delivered concurrently with the planes for which they are designed. The discussed plan is reported to include not only consideration of what parts and how many of them are to be made and delivered, but also a detailed formula for the order in which they are to be made, the specific maintenance purposes they are expected to serve, and the theoretic number of planes they are expected to keep flying for a specific theoretic period of time. Details are given on the echelon system of determining the nature and quantities of spare parts. *Western Flying*, September, 1943, pages 50, 52, 104, 106, 2 illus.

How to Mass-Produce the Helicopter—That Is Our Question. George W. Mason. The President of Nash-Kelvinator comments on problems connected with the mass production of helicopters. He states that not only is the exterior design of the helicopter new to the eye and to the production process but its inner workings are likewise novel. The gear assemblies that operate the rotating blades, both vertical and horizontal, present new assembly problems. The writer reviews briefly the other aircraft activities being carried on by his company. *Midwest Aviation and Yachting*, September, 1943, pages 9, 26, 1 illus.

Production Control. W. V. McClung. The method of production control used at the Vultee Field Division of the Consolidated Vultee Aircraft Corporation is described. As a prelude to the description, the relationship of the production control department to the various other departments is explained with the aid of a chart. Production control is treated under sections covering the formulation of the schedule, order release, fabrication shop paper, cost center dispatch, plant layout, interdepartmental transportation, the arrangement of assembly departments with separate cost centers, and major assemblies of the airplane. *Mechanical Engineering*, October, 1943, pages 727–731, 6 illus.

New All Wooden Fuselage for the Canadian Anson. A. E. Salter. An account of how the Canadian firm of Cockshutt Moulded Aircraft Ltd. builds fuselages of molded plywood



The Scherr Comparatrol gear tester. (*See* page 175.)

construction for the Anson V. After some brief data on the organization of the company, its plant, and personnel, the article goes on to describe fabrication and assembly processes, materials, and equipment. Facilitation of the manufacturing procedures is attributed in large part to improvement in the design of the fuselage. The new fuselage is designed for simplified construction in three parts. *Canadian Aviation*, September, 1943, pages 81, 82, 84, 86, 88, 90, 92, 22 illus.

Rivet Salvage. A sorting scheme for salvaging rivers is outlined which permits the employment of blind operatives. Developed by Blackburn Aircraft, Ltd., the method is based upon a specially designed machine for sorting the rivets according to length and type. Yielding a marked improvement over rivet-salvage results with other systems, the machine is of simple design and is made largely of plywood and old templates. Illustrations help to explain its construction and operation. *Aircraft Production*, September, 1943, pages 453, 454, 5 illus.

Cooperation of Sub-Contractor on Fleet "Cornell." A series of notes with regard to the manufacture of "Cornell" wings and parts by the subcontracting firm of Dominion Industries, Ltd. After a brief history of the company and of its experience with plywood manufacture in other fields, certain features of the wing construction and production processes are referred to. *Commercial Aviation*, August 1943, pages 63, 64, 3 illus.

New Method of Making Metal Drop Hammer Dies. Harvey G. Groehn. As developed by the Castaloy Corporation, a method of making metal drop-hammer dies for prototype and sample parts is examined briefly. The process is based upon the use of Cerrobend, a standard alloy that remains molten at such low temperatures that it can be pumped through a long hose to any job that is ready for pouring. By partially submerging the molds in a cooling liquid the newly cast dies are cooled in a short time and metal thicknesses are added by a special spraying technique. The production life of the final die is reported to be from one to 50 aluminum, steel, or plastic parts. Chief advantages of the procedure lie in the saving of time required to produce a die and in the accuracy of the die produced. *Aero Digest*, September, 1943, pages 229, 231, 4 illus.

Tolerance and Dimensional Control. Harold Adams. A discussion of the effect on airplane production of tolerance and dimensional control. It is stated that the elimination of rework required on assembly to make parts fit is one of the problems confronting the aircraft industry, the solution of which may reduce manhours spent in air-frame production as much as 20 per cent. *Mechanical Engineering*, October, 1943, pages 739, 740.

Furnace Brazing. D. H. Smith. Details are presented on a new furnace-brazing technique for the manufacture of thin-wall landing-gear components. Employed by the British firm of Messier Aircraft Equipment, Ltd., this process is claimed to effect a great economy of both time and material. Basically, it consists of making the components from light-gauge drawn-steel tubing, onto which the collars and fittings are pressed and then furnace-brazed to position with copper. Specific attention is given in the article to the questions of distortion, fluxes, clearances, and the strength of the joint. The application of the technique to control jacks and the tests for establishing the degree of penetration of the copper within the joint in relation to the mating parts are also studied. Results of tests determining the effect of applying copper at the clearance and interference ends of tapered test pieces are tabulated. Another table lists the comparative weights of assemblies made by the old and new

Metallurgical Help for "The Little Man Who Isn't There"

The gyro-pilot is aptly nicknamed the "Little Man Who Isn't There." The device provides marvelous relief for pilots on distance flights, keeping the plane on its course with uncanny accuracy, despite wind and weather.

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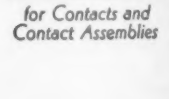

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methods, demonstrating a saving of 30 per cent in raw tube material. A third shows the fit tolerances adopted for furnace brazing by Messier Aircraft Equipment. *Aircraft Production*, September, 1943, pages 411–414, 6 illus.

Research Applied to Practical Production Redesigning of "Cornell" Oleo Leg. George Otter. This article relates how the redesign of the Cornell and PT-26A main landing gear effected a threefold saving at Fleet Aircraft through the conservation of raw or partially fabricated material, of manpower, and of replacement parts by salvaging the undamaged portion of the undercarriage. The redesign consisted of (1) making the fork side plates in two pieces instead of one and welding along both the inside and outside edges; (2) changing from acetylene welding to arc welding; (3) making the cylinder as a separate unit pressed into the fork; and (4) making the hydraulic hose clamp as a separate unit. In addition to details on the differences in production procedures necessitated by the changes, the article also includes a cost comparison between the original and the redesigned undercarriages. *Commercial Aviation*, August, 1943, pages 64, 66, 68, 6 illus.

10,000 Airplanes a Month Is Well Within Sight. A brief and general analysis of the present status of American and enemy airplane production. It is claimed that, with America approaching a total of 10,000 planes per month, the building-up phase of the war is coming to an end and that the problem is no longer one of production but one of operations and logistics. On the other hand, it is surmised that Germany has been building up her supplies and powers of defense. In addition, it is stated, there is an advantage for her in being able to concentrate on fighter plane production while America must build and operate the more complicated bombers. Therefore, the warning follows, there is a hard fight ahead before the war will be won. *U.S. Air Services*, September, 1943, pages 13, 15.

Rubber Dies for Small Presses. A. Bernard. An article on the use of bench-type machines for blanking and forming small parts with the rubber-die principle of processing. From results obtained with experiments on small fly presses, the writer recommends the practice as well worth consideration. He describes the type of hand-press tool used, the action of the rubber pad, methods of piercing holes, and the forming of double bends. *Aircraft Production*, September, 1943, pages 415–417, 6 illus.

News from Germany. A discussion of the limitations of German productive capacity which have prevented the introduction of new service aircraft in large numbers. The inadequacy of the German production potential is considered particularly with regard to factories building single-seater fighters and those manufacturing airplane engines. As an indication of the necessity for Germany to get the maximum utility out of each aircraft type because of her shortage of labor and raw materials, the planned multipurpose of German aircraft is examined. The article includes a brief survey of the centers that are producing fighters and the model upon which they are concentrating. With regard to engines, the tendency of the Luftwaffe to use radials for military aircraft is attributed also to Germany's limited productive capacity. *The Aeroplane*, August 6, 1943, pages 153, 154, 1 illus.

The development of Aircraft Detail Fittings—Part I. W. Cookson. The first of a series of articles in which aircraft detail fittings are discussed. One of the most important features of pattern development for precision sheet metal work is the correct calculation of bend allowances that take into consideration the thickness of the metal. The calculation methods employed for bend allowances are explained under sections covering the use of bend allowances, a typical control cable cover, obtaining the bend allowances, geometric construction for the pattern, triangulating the pattern, and adding flanges to the pattern. *Sheet Metal Industries*, September, 1943, pages 1575–1578, 5 illus.

Planes by the Thousands. The work of the Production Division of the Army Air Forces' Matériel Center at Wright Field is described. Evolving from the original Wright Field Engineering Section, it is reported that the functions of the Production Division are now carried out by three sections —Production Engineering, Production Control, and Industrial Planning. Details given on the particular activities and responsibilities of each section and its subsidiary branches impart some idea of the complex problems of scheduling, production and parts control, and equipment modifications which are involved in the production of 90,000 airplanes a year. *Flying*, October, 1943, pages 132, 133, 312, 316, 3 illus.

Balanced Aircraft Production. A summary of the report on British aircraft production by the Select Committee on National Expenditure. Disclosing no serious bottlenecks, the report recommended that output could only be increased by improving the efficiency of the industry. The series of 24 proposals for so doing are outlined in this article. Two aspects of British aircraft production with which the Committee was not satisfied were the condition of "spare" manufacture and the lack of qualified personnel. *Flight*, October, 1943, pages 223–225.

The Tharratt Method of Production Illustration. O. J. Chayie. The article describes a means of reducing engineering drawings to perspective diagrams that are intended to provide essential information in accurate terms and help the eye in an appreciation of the shape of aircraft parts. *Aeronautics*, September, 1943, pages 46–53, 10 illus.

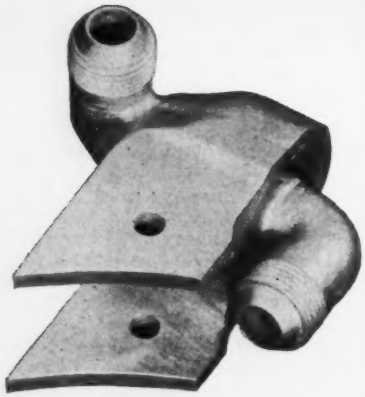
Propellers

Reflections. Bryan Greensted. The chief test pilot for Rotol Airscrews presents a brief general review of the work of his department since its inception in May, 1939. His comments refer to the types of propellers that have been flight-tested in the four years—from two blades to as many as can be put into a single hub; constant-speed and feathering-up to the six-blade contrarotating, constant-speed propeller for engines of over 2,000 hp. He relates that the Rotol Flight Test Department, while conducting endurance, performance, and operating tests for basic types of bomber and fighter propellers, also carried out special investigations for such items as hydraulic pitch locks, devices to prevent overspeeding, suitability and simplifications of controls, deicing, and electric propellers. From a point of view of handling characteristics, the writer strongly advocates a contrarotating form for all propellers. He states that the new phase of propeller development will be devoted to promoting propellers that contribute largely to the ease and comfort of the pilot. *Flight*, August 12, 1943, pages 169, 170, 1 illus.

Britain Develops Aircraft Propeller. The history of the development of aircraft propellers in Great Britain is outlined. It is noted that three British scientists evolved a variable pitch propeller nearly 20 years ago. At that time propeller blades were all made of wood, and trouble was experienced in making a satisfactory attachment between the blades and hub. Before a really satisfactory solution to the problem was formed the metal blade and the compressed-wood blade were devised. Neither presented much difficulty in attachment to the hub. Other sections of the article discuss the constant-speed propeller, four-blade propeller, and counterrotating propeller. *Indian Aviation*, April, 1943, pages 98, 99, 1 illus.

Radio

Aviation Uses of the Amplidyne. R. A. Averitt. An explanation of the principle embodied in the amplidyne and a survey of some of its aeronautical applications. Among the reported applications is its use as a control device for guns in aircraft turrets, antiaircraft guns, fire equipment, etc. Six functions contributing to the amplidyne's versatility are outlined. They are: (1) It controls speed accurately over a wide range. (2) It limits loads, to protect electrical and mechanical equipment. (3) It controls torque and tension to improve product uniformity in winding, drawing, and other similar operations. (4) It speeds up acceleration and de-



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celeration to increase production of high inertia machines. (5) It positions machine tools and arc-furnace electrodes, simply and precisely. (6) It regulates current, voltage, and power. *Aero Digest*, September, 1943, pages 177, 179, 250, 10 illus.

Radio-Noise Filters Applied to Aircraft. C. W. Frick and S. W. Zimmerman. Since commutators and other forms of arcing contacts used in aircraft ignition, lighting, and control equipment may cause interference with radio under some conditions, careful planning is necessary to get the fullest use from both types of electrical equipment without overburdening the aircraft with attachments. The proper application of radio-voice filters is discussed in sections covering available filters, factors entering into the problem of interference control, the use of suppressors in aircraft, and tests required to check the performance of filters. A laboratory circuit for filter-performance tests is described in an appendix. *Electrical Engineering*, September, 1943, pages 590–595 (Transactions), 12 illus.

"Calling Flight 17 . . . " Robert McLarren. The role of radio communication in America's air power is described. It is noted that radio has made possible communication between pilots in the air and between pilots and directing ground stations, the transmission of timely weather information, the navigation of the airplane, landing of the airplane during conditions of darkness or poor visibility, and the instantaneous relaying of vital information.

Some remarks are made on the principle of radio communication. Information is given on the short-wave bands normally used for aircraft radio. The radio equipment used on different types of military aircraft is described. The method of procedure established by the United States for radio communications and to the many rules and regulations connected with this procedure are referred to. *Model Airplane News*, October, 1943, pages 6, 7, 50, 52, 54, 3 illus.

Rotating Wing Aircraft

Mr. Public Okays the Helicopter. William B. Stout. Some technical aspects of helicopter designs are discussed. The action of the rotor in the helicopter and the autogyro are compared. Further improvements in helicopter design are discussed. *Midwest Aviation and Yachting*, September, 1943, pages 6, 7, 24, 2 illus.

Stress Analysis

Effects of Yielding and Perforations on a Wing Tension Surface. Richard K. Koegler and Arthur Schnitt. Two different but interdependent ideas concerning stress calculations are presented. Perforation effects on stress-strain curves are first investigated. A method of calculating these curves

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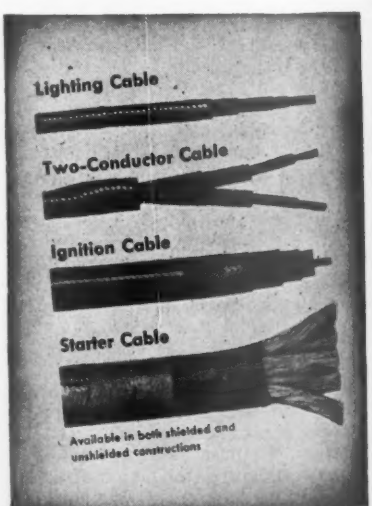

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for any gauge length, perforation size, and spacing is shown. This method depends on an effective perforation length and an ultimate stress concentration factor. Test data are given to substantiate the method. Tentative curves are presented from which the effective perforation length and stress concentration factor for various perforations can be found for use in engineering calculations.

The method of accounting for yielding in ultimate strength calculations is next presented. It consists of applying stress-strain curves to the strain distributions found in the elastic range. Its practicability and validity depend on the fact that in the plastic range the stresses determined will not be seriously in error for moderate variations of strain. Examples based on a two-beam wing with heavy 24ST extruded flanges show that calculations neglecting yielding may indicate failure in the wrong member and at too low a load (15 per cent in a typical case). In addition, if an appreciable length of surface yields, shear lag may be seriously affected.

The method applies to many cases besides the one shown. Because of the slow increase of stress with strain after yielding, approximate calculations afford reasonably accurate results, and it may be found in the future that yielding effects will simplify many stress calculations rather than complicate them. *Journal of the Aeronautical Sciences*, October, 1943, pages 273–284, 17 illus.

Tension Joints in Aircraft Structures. Clarence H. Holleman. The basic assumptions of conventional riveted joint design practice are discussed with respect to their applicability to aluminum alloys. Data are presented to establish the effect of holes on the tension efficiency of 24ST aluminum-alloy sheet, and values are proposed for use in riveted joint design. Information is presented showing the effect of hole size, hole type, number and spacing of holes, number of rows, and amount of stagger.

A series of tension tests of riveted skin splices is discussed, and suggestions are offered for obtaining the maximum possible efficiency in continuous joints. *Journal of the Aeronautical Sciences*, October, 1943, pages 295–302, 310, 12 illus.

On the Torsional Damping Capacity of Solid Magnesium-Alloy Rods as Affected by Cold-Working. A. U. Kutsay and A. J. Yorgiadis. The necessity of associating the damping capacity of magnesium in torsion, with both the shearing stress amplitude and the cold-work history of the material, is discussed.

Consideration is given to the relative merits of the "freely decaying vibrations" method, and the "sustained resonant vibrations" method for the dynamic testing of magnesium.

Test results on the torsional damping capacities and dynamic moduli of rigidity are given for two extruded magnesium alloys, O and J, tested under sustained resonant vibrations. The vibrations were induced to solid cylindric magnesium specimens by a mechanical oscillator driven by a synchronous motor.

The effect of various degrees of cold-work on the dynamic properties was investigated and found to be of utmost significance in that cold-working decreased the damping capacity considerably, thus showing the danger in neglecting the effect of cold-work on the induced stress in a member vibrating at resonance. *Journal of the Aeronautical Sciences*, October, 1943, pages 303–310, 12 illus.

Letters to the Editor. Remarks are contributed in the form of three letters to the editor with reference to the article titled "A Tabular Method of Propeller Blade Stress Analysis," by Joseph Stuart, III, appearing in the JOURNAL OF THE AERONAUTICAL SCIENCES, April, 1943.

In the first of these Sydney D. Black proposes that by the use of a simple algebraic means no estimation of the trial root moment is necessary, making the Stuart method a direct method rather than a method of successive approximations. It is offered as a means for eliminating the difficulties that arise in the analysis of unusual blades and in cases where accurate evaluation of tip-bending moments becomes necessary. Two tables accompany the letter.

The second letter, by N. O. Myklestad, suggests some improvements in the proposed method of analysis, whereby it is stated that all trial-and-error methods can be avoided by the substitution of three sets of calculations. These are explained and a procedure is outlined for finding the exact effect of blade-section eccentricity.

Suggestions are made in the third letter, by R. C. Rand, for substituting a set of linear equations of the "triangular" type for the standard method of solution. It is stated that in this way full advantage can be taken of the linearity for interpolation at every station, requiring only two guesses of the root moment to determine correct moments at every station. This is contrasted with the method used in the paper—of interpolation only at the tip to make a third accurate guess. Also, it is stated that the "one-fourth" rule offered is not practical for all blades and that it is better first to find directly the slope of the graph shown in Fig. 4 of the original paper. *Journal of the Aeronautical Sciences*, October, 1943, pages 317–319.

An Airscrew-Engine Analogy. T. H. Day. It is shown that a close analogy exists between the system of forces acting on the blades of a propeller and on a direct-acting engine. Formulas for the forces acting on an element of a propeller blade and the forces acting on a direct-acting engine are derived and compared. The analogy between the two systems of forces is pointed out. The discussion is continued under sections dealing with the system of forces acting on the whole blade, the forces acting on a propeller blade for various conditions of flight, the corresponding configuration of crank and connecting rod, the relation between windmills and the direct-acting engine, the relation between propeller and windmill diagrams, and counterrotating propellers. The illustrations include sketches showing views of blade sections and corresponding views of the engine. *Aircraft Engineering*, August, 1943, pages 218–222, 35 illus.

Weighing Data as Applied to Structural Analysis. John C. Reams. The expanding functions and responsibilities of the weight engineer are discussed in a review of the contributions of that branch to the work of stress analysis. The various loads are defined and the preparation of the shear diagram is traced. In connection with the information that must be provided for the structures engineer, the calculation of bending moments is explained. A table gives a breakdown of the equipment distribution in the fuselage of multiengined aircraft, showing the percentages of the total weight represented by the different components. *Aero Digest*, September, 1943, pages 243, 245, 247, 6 illus.

The Problem of Wing Oscillation. Zbigniew Krzywoblocki. The steady increase in speed and use of thin airfoils compels a deeper consideration of the problem of oscillation. This and the recent tendency to the building of large airplanes are closely connected with the problem of oscillation. The writer, in a first approximation, tries to solve, from a proportionality point of view, the question of influence of the kind of material and size of airplane on wing flexural and torsional natural frequencies. Following the idea of solving this problem from a qualitative and not from a quantitative point of view, the conception of proportionality instead of equality is introduced. The idea of "wing torsional rigidity" is introduced, being inversely proportional to the angle of twist at the end of the wing. Applying Newton's law, the flexural and torsional natural frequency of an oscillating rod is found first. Next, the method is used in the case of an oscillating tubular member. The results are checked by Rayleigh's method. Finally, the influence of size of wings having similar shape is taken into consideration. *Aircraft Engineering*, August, 1943, pages 234–237.

Superchargers

Temperature Effects on Turbine Supercharger Installations. Philip Colman. In order to obtain consistent flight test data for airplanes with turbine superchargers, account must be taken of the variation of engine brake horsepower with changes in atmospheric conditions. The variation of power available with the change of free air temperature is greatly mag-

nified by the complexity of the induction system when the turbine supercharger and intercooler are included.

The limits of power available on any day are dictated by one of the following three conditions: (1) the engine manufacturer's specified manifold pressure and engine r.p.m. values; (2) the turbine manufacturer's specified maximum allowable turbine wheel speed; and (3) the engine manufacturer's specified maximum allowable intake port temperature. The power available at any altitude may be calculated. However, these calculations can only be approximate, and therefore it is suggested that complete charts be derived based on the data available and that all flight test data be corrected to standard conditions by use of the increments shown on these charts. Once a standard day power chart has been derived for a turbine-equipped airplane from flight test data and the correction charts, all future flight tests may be corrected to this power chart. The steps then become identical to those currently used to correct flight test data for airplanes with only single-speed geared engine superchargers. *Journal of the Aeronautical Sciences*, October, 1943, pages 261–269, 9 illus.

Testing

Use of Dry Ice for Testing. Details are given on a system of cooling aircraft testing rooms by means of dry ice immersed in methyl alcohol, typified by a laboratory designed and constructed for Douglas Aircraft Company, Inc. The addition of the alcohol to the ice eliminates the entrance of carbon dioxide into the test chambers and prevents the accumulation of frost and water ice around the dry ice. This refrigeration method is said to be of the greatest value when the factors of low cost, simplicity of operation and maintenance, and infrequent use are important. In the case of test rooms, which must be operated constantly with a high-load factor, the use of refrigeration compressors is indicated as being more desirable because of low operating costs. *Aero Digest*, September, 1943, page 222, 1 illus.

Air Forces Proving Ground. How the battle combat worthiness of Army Air Forces' aircraft, accessories, equipment, and supplies are tested and evaluated at Eglin Field by the Proving Ground Command. At this and similar fields the performance characteristics and capabilities of A.A.F. combat tools are subjected to exacting tests which prove their fitness for tactical use and demonstrate how they may be employed with maximum effectiveness. In addition to recounting the working procedures of the Proving Grounds, the article also reviews the establishment of Eglin Field and several of the aviation developments that have resulted from testing and proving activities. The work is divided among the following five Proof Department Sections: Bombing; Machine Gun and Cannon; Tactical; Radio; and Miscellaneous. *Flying*, October, 1943, pages 130, 131, 332, 333, 4 illus.

Capable of testing and overhauling aircraft spark plugs in the shop or field, the tester shown operates by hand crank when 110-volt power is unavailable. (*See* page 165.)

British Aircraft Bond Tester. A description of the construction and operation of the Megger Aeroplane Bond Tester. This is a device for testing the electrical resistances between any two metal points of a structure. The instrument and its operation are described. Its range is 0–0.1 ohm. *Commercial Aviation*, August, 1943, page 72.

Testing Equipment

A Multiple Recording Manometer. Paul J. Campbell. An instrument for recording the pressures encountered in wind-tunnel testing is described. The pressures to be measured are balanced against an accurately controlled variable pressure by means of thin leather diaphragms. The pressure at which each diaphragm becomes balanced is electrically recorded on a chart. Eighty pressures may be recorded in less than a minute. *Journal of the Aeronautical Sciences*, October, 1943, pages 313–317, 3 illus.

Tools and Equipment

Hand-Stoning Conserves Cutting Tools. The advantages of hand-stoning the edges of cutting tools after rough grinding are noted. Saving time and machine-tool steel, the hand-stoning eliminates the microscopic but detrimental serrations that are left on the tool after grinding. Two basic types of stones are recommended for the process: One is made of Norton's electric furnace "Alundum" abrasive; the other is of Hard Arkansas, a natural stone mined in the Ozarks. *Aero Digest*, September, 1943, pages 201, 267, 3 illus.

Training

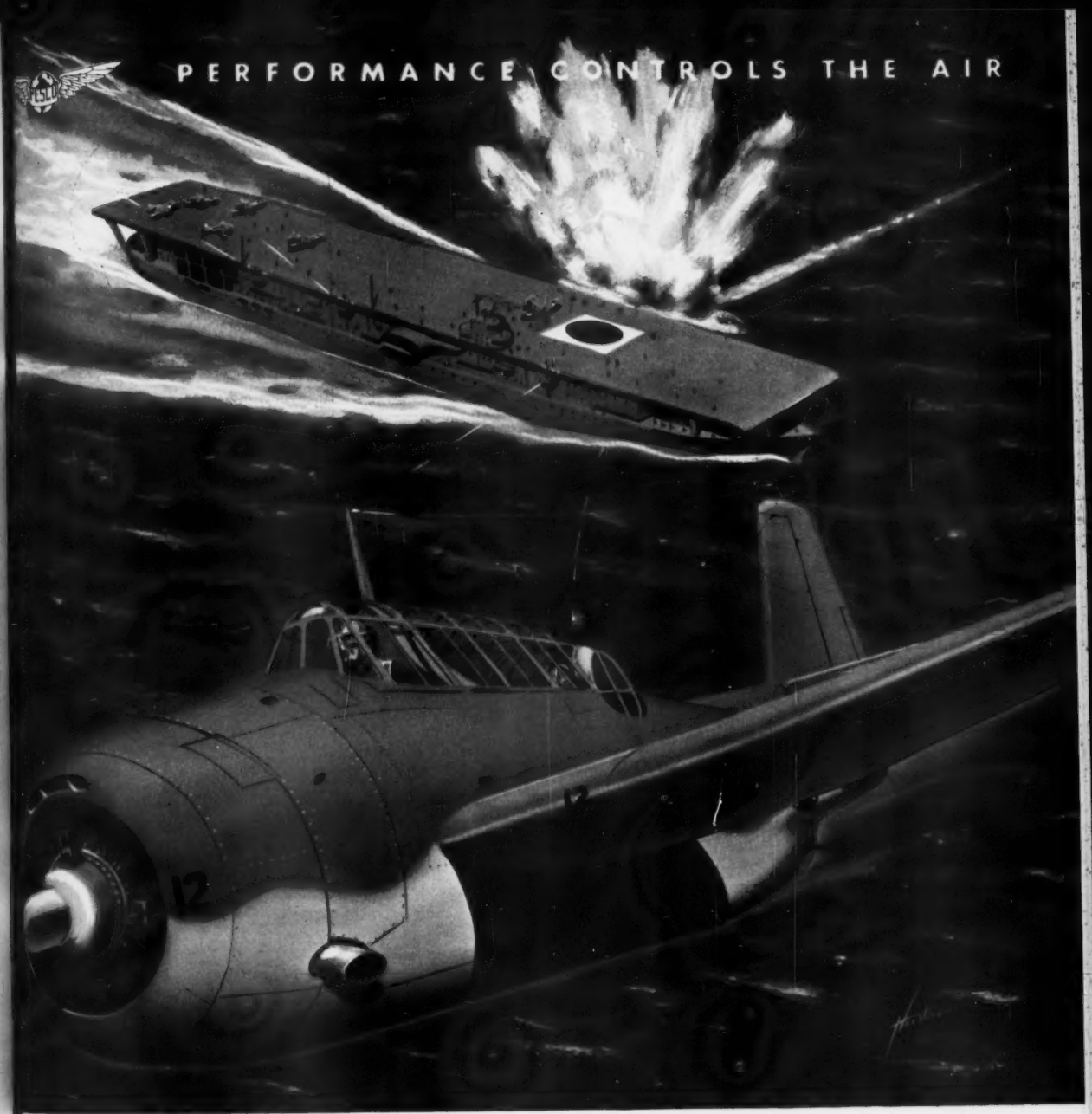
Polishing a Pilot. This is the third article in a series on the primary, basic, advanced, and transitional flight training schools of the Army Air Forces Western Flying Training Command. Based on an interview with the commanding officer of Luke Field, it is concerned with the general policies, methods, and courses of the advanced phase of instruction and their particular applications at Luke Field. *Western Flying*, September, 1943, pages 42, 43, 98, 4 illus.

Training Women for Engineering Tasks. E. D. Howe. Three major questions that may be asked in connection with the training of women for engineering tasks are: (1) Is there a real shortage of male engineering workers so that women must be used? (2) Are there any particular engineering tasks for which women may be trained as readily as they are trained for stenography or other business-office tasks? (3) Can women capable of doing these engineering tasks be found and trained?

It is stated that "the first question can be answered in terms of the publications of the War Manpower Commission, and the other two in terms of the work done by Engineering Science and Management War Training Programs, such as the one operated by the University of California." Some of the answers to these questions are considered in sections covering the need for employing women, engineering jobs for which women should be trained, recruiting and training women, and results of the program. *Mechanical Engineering*, October, 1943, pages 742–744.

First Impressions of a Fortuneteller. Bruce Keith. The writer discusses the navigation course taught at Canadian Air Observer Schools. He describes how a navigator spends his days at school and tells about what is taught during the first two or three weeks of the course. *Canadian Air Cadet*, September, 1943, pages 7–9, 4 illus.

H.M.S. Fledgling's Women Mechanics. An account of how members of the Women's Royal Naval Service trained to become air mechanics at H.M.S. Fledgling, a British Naval Air Training Station. The article covers the qualifications of the girls, the courses given to each classification of air mechanic trainee, their chances of promotion after graduation from the school, and their abilities at the mechanics' jobs. Wrens are trained for four categories of air mechanics: air frame, engine, electrical, and ordnance. Although taught separately,



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Knockout! Down before the torpedo bomber go the mightiest heavyweights of the enemy fleet. Through skies stark mad with defensive fire these planes close in to deliver their telling blow. A crucial test of both pilot and plane. Each torpedo striking home salutes the skill and daring of our flying sons, and craftsmanship of the millions here at home whose precision workmanship rules the sky. Pesco Products Co., 11610 Euclid Avenue, Cleveland 6, Ohio, (Division Borg-Warner).

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New INTERNAL-PIVOT ELECTRIC INSTRUMENTS

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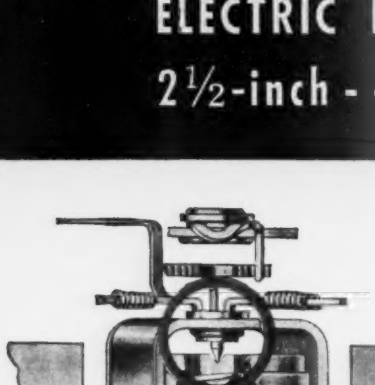
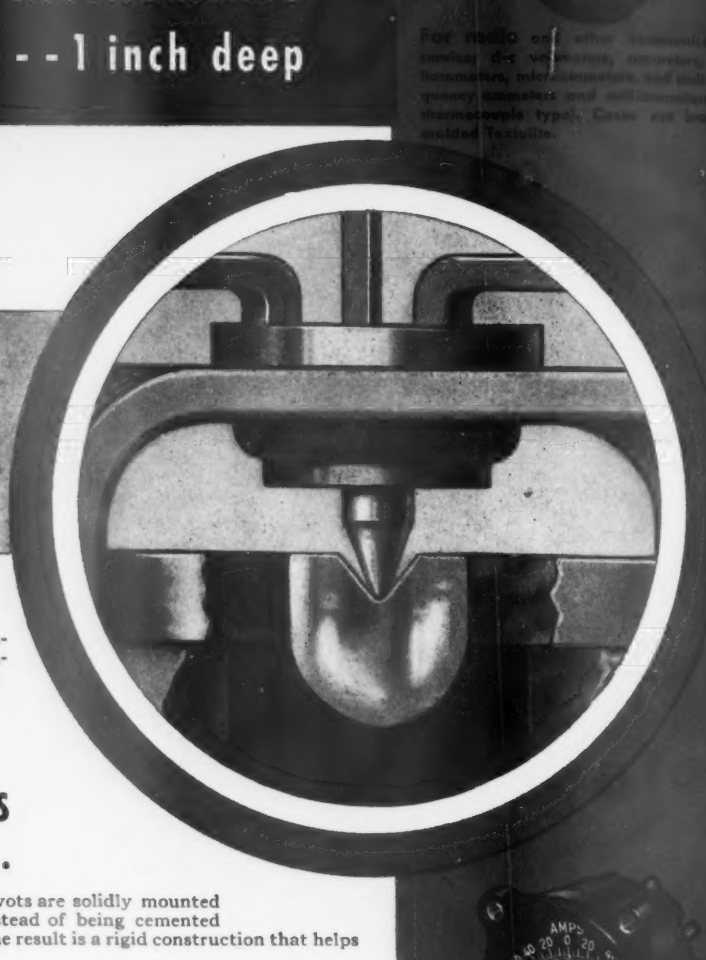




(Above) The new internal-pivot bearing construction. (Right) Top bearing (pivot and jewel) magnified 20 times. Note strong, solid construction.

WHY THIS BEARING CONSTRUCTION INSURES LONG-TIME SERVICE . . .

IN THESE new G-E instruments, the pivots are solidly mounted on the *inside* of the armature shell instead of being cemented to the outside of the armature winding. The result is a rigid construction that helps to maintain accurate alignment.

The steel pivots, highly polished, are of the aircraft type, larger than normal. This means less stress on the bearing surfaces and a construction that will stand rough treatment and shock.

The pivots rotate in low-friction, highly polished, glass vee jewels—one mounted rigidly in the top of the frame-and-core assembly, and the other mounted in a movable lower jewel sleeve located in the soft-iron core.

This combination—accurately formed, hard-glass jewels and large-radius steel pivots—provides a co-ordinated bearing that has proved, by field tests, to be excellent from the standpoint of long life and ability to withstand vibration.

Thin, Strong, Accurate Instruments

1. *Thinness* is obtained by solidly mounting the pivots on the inside of the armature shell. Most instruments are approximately one inch deep.
2. *Strength* is obtained by short, solidly mounted, large-radius pivots and the extra-strong over-all case.
3. *Sustained Accuracy* is insured by the featherweight moving element, combined with high torque and permanent alignment of all parts.

For ratings, prices, and dimensions, ask our nearest office for Bulletin GEA-4064, which covers instruments for use in radio and communications equipment; or Bulletin GEA-4117, which describes those suitable for naval aircraft. *General Electric Co., Schenectady, N. Y.*

D-c voltmeters, volt-ammeters and ammeters are specially designed to measure voltage and current in battery and battery-charging circuits on aircraft. They meet applicable Navy specifications.

GENERAL ELECTRIC

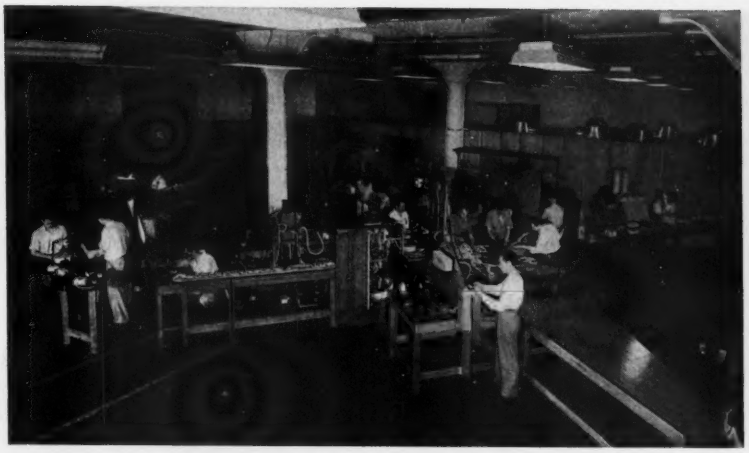
SMALL PANEL INSTRUMENTS

they are on the same basis as men learning the same trades. Courses for all four categories of Wren air mechanics last about 18 weeks and are divided into different phases, with an examination about every 4 weeks. Theory and practice are combined and the basic training for each category includes both "aircraft acquaintance" and the acquisition of skill in the use of tools. *The Aeroplane*, August 6, 1943, pages 155–158, 12 illus.

Invasion Pattern. Ronald A. Keith. The system of training instituted at Camp Shilo for the instruction of Canadian parachute troops is outlined. Beginning with a review of the achievements of allied paratroopers in North Africa and Sicily, the writer compares the English and American techniques of training paratroopers, reports that the Canadian sequence incorporates features of both American and English methods, and proceeds to detail certain of the training maneuvers. As related, the four progressive 1-week stages of instruction at Camp Shilo are devoted to physical conditioning, jump techniques, height and drop conditioning, and qualifying jumps. Requirements for Canadian paratroop volunteers and the emphasis placed upon special night vision tests are noted. *Canadian Aviation*, September, 1943, pages 45–48, 78, 8 illus.

Planetarium. An article describing how naval officers are trained in navigation with the aid of a small planetarium at the Central School, Toronto. The dome of this planetarium measures 21 ft. across, stands 15 ft. high, and shows the stars of the Northern sky in their proper colors and places. On the base circle of the dome—the Ecleptic—are all the signs of the constellations of the Zodiac in twelve sections of 30° each. Seats to accommodate 40 to 50 students are located in a semicircle around the dome. *Air Force Review*, September, 1943, pages 11, 29, 5 illus.

Aeronautical Obstetricians. George R. Clay. Some of the problems of instructors in the War Training Service program and the difficulties with which they have to contend are discussed. Among the problems are: The differences between the Army and Navy training systems; the ambiguity of the instructors' military status and the recommendation that they be enlisted in the Army and Navy Reserves; the order to have War Training Service personnel wear uniforms; and the substitution by the Navy of flight maneuvers other than those required by the C.A.A. General Inspection Branch. It is suggested that the quality of instruction might be improved if the C.A.A. were to allow its instructors to be transferred from operation to operation. Another suggestion made on behalf of the instructors is that each man be limited to five students at a time and that, like the instructor in Army primary, his schedule be fixed to half a day of work. *Southern Flight*, September, 1943, pages 32–34.



Shown here is an operating "model" of the current Martin PBM-3 Mariner's electrical system by which naval personnel are being trained in the functioning of the various electrical devices and instruments of the airplane. (*See* page 171.)

"AAFSAT." This article deals with the purpose, activities, courses, facilities, and equipment of the Army Air Forces School of Applied Tactics. It describes in detail how every phase of actual warfare is simulated in this Florida "war theater." The first school of its kind in military training history, A.A.F.S.A.T. has a threefold purpose: (1) to train Air Force cadres—the personnel framework around which all new combat groups are formed; (2) to test and develop new techniques; (3) to speed new developments and methods out to the theaters of combat. In addition to listing the advantages of this training program for the nuclei of operational units, the article notes both the qualifications of the personnel who are trained at A.A.F.S.A.T. and the experience of the personnel who are instructors. It directs attention to the specific procedures of the school's four departments—Air Defense, Air Support, Bombardment, and Air Service. *Flying*, October, 1943, pages 80–82, 256, 260, 268, 6 illus.

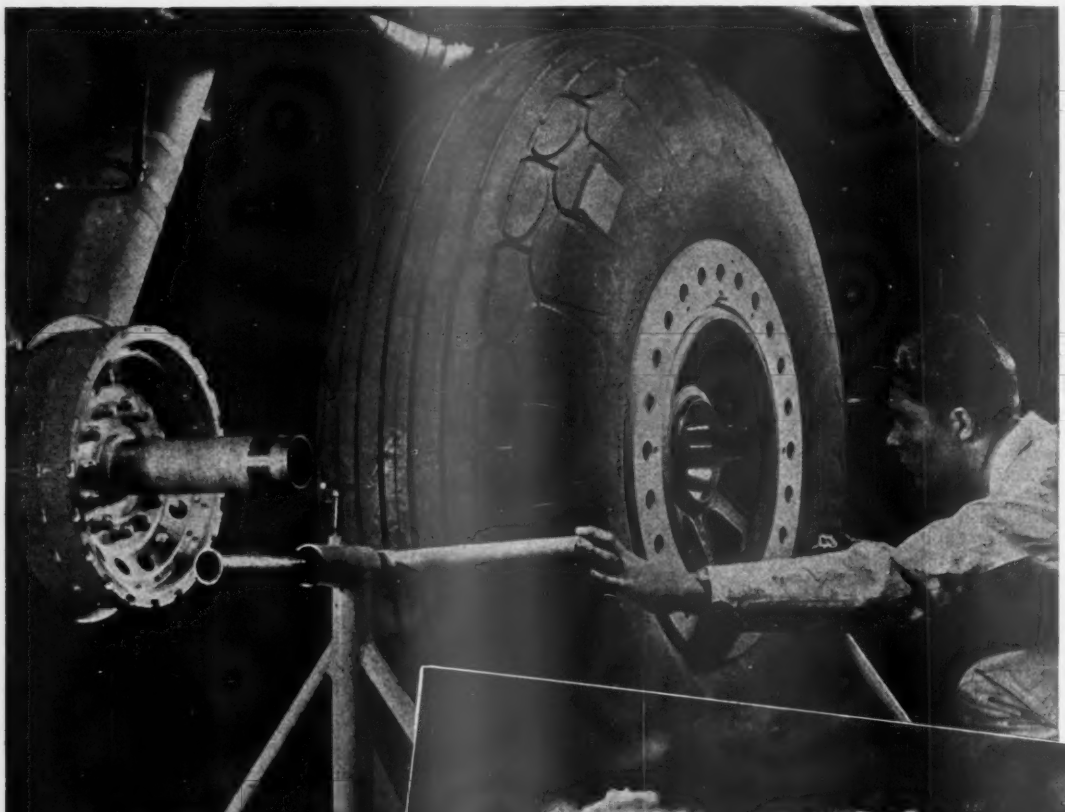
Split Second Recognition. "Spotter." An article on the new instruction technique employed in the British Commonwealth Air Training Plan for the instantaneous recognition of aircraft. Based upon the science of "optics," the system is said to combine the best features of British and U.S. Navy methods. In a six-week course the student is taught to recognize airplanes, beginning with a study of individual plane characteristics. The 222 hours are divided among instruction on 70 different types of aircraft, optical and "digit" training, range estimation, estimation of numbers, mutual instruction, sketching, and such contributing factors as physical training and drill to teach alertness and coordination. *Canadian Aviation*, September, 1943, pages 64, 79, 2 illus.

Warfare

Pattern of War via Tactical Air Power. Merlin Stonehouse. The writer outlines the operating principles of tactical air forces, describes their advantages, and relates how this phase of air fighting was developed in the North African campaign. He explains that tactical air warfare bars the dissipation of air power and calls for a concentrated attack from massed airplanes against the weakest point of the enemy's defense line. As opposed to the strategic use of air force—swinging out over great distances and hitting at remote objectives—tactical air power operates with ground forces against immediate objectives. The successful application of this type of air warfare is reported to have resulted in a changeover from the old idea of air action "supporting" ground troops to the new conception of air-ground coordination and mutual support. *Skyways*, October, 1943, pages 30–32, 58, 91, 7 illus.

This War Is Not Over. Capt. Eddie Rickenbacker. Some observations on the trends of the war as culled from Captain Rickenbacker's third mission to the fighting fronts—a trip embracing South America, North Africa, China, India, Russia, Persia, England, Iceland, Greenland, and Labrador. In evaluating the fronts, he claims that the Southwest Pacific is the most difficult. Following in order of difficulty, he names the Aleutians and the Russian front. The first two are designated primarily as air theaters; the last, as an Army and air front. Air operations are also stated to be the most important on the Chinese, the Mediterranean, and English fronts.

Among his comments, the writer reports on the deterioration of German fighting against the Russians, the treatment of absenteeism in Russia, and the large percentage of women employed in Russian factories. *Aero Digest*, September, 1943, pages 115–



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Easy does it *says the Pilot*

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118, 8 illus.; *Airlanes*, September, 1943, pages 2, 3, 1 illus.

Evaluating Aerial Tactics. Major Oliver Stewart. A study of the relative tactical effectiveness of fighters and bombers. While the work of fighters during the Battle of Britain is exemplified as the performance most nearly approaching tactical perfection, the conclusion is that there is a general trend toward improvement in all branches of air work. This is attributed to the fact that Allied air forces are not only stronger than ever before but that they have accumulated experience in operations which enables them to be more effectively deployed and used. *Western Flying*, September, 1943, pages 39, 58, 1 illus.

Red Falcons on the Wing. An Observer. Some of the long-range strategic bombing operations carried out by the Russian air force against Germany since the spring of 1943 are reviewed. To depict the extent of the air fighting, figures are presented on the losses suffered by both sides. In addition to noting particularly the actions against German supply lines, the article includes a brief survey of the planes employed by the Germans and the Russians. The latter list consists of both Russian- and American-manufactured airplanes. *Skyways*, October, 1943, pages 22, 23, 40, 78, 1 illus.

Bombs on Germany. Official Air Ministry figures are reported on the tonnage of bombs dropped by the Royal Air Force on Germany, as well as the tonnage dropped by the Luftwaffe on Britain, from the third quarter of 1940 through the second quarter of 1943. The figures for the R.A.F. show a rise from 2,750 to 36,700 tons; those for the Luftwaffe show a drop from 18,900 to 700 tons, with a record for some periods of only 250 tons per quarter-year. Comparison of the figures is also afforded by an accompanying graph. *Flight*, October 26, 1943, page 236, 2 illus.

Welding

The Application of Flash Welding in Airplane Construction. C. B. Smith. The flash-welding process as used by Douglas for the welding of aircraft is described, and the research program established for the purpose of solving welding problems is discussed. Two of the problems investigated were the development of a flash-welding technique that would consistently produce reliable results and the determination of the strength values of flash welds made with this technique. Solutions found for these and other welding problems are described. The exact procedure for setting up a new flash-weld job is reviewed. *The Welding Journal*, October, 1943, pages 769–775, 15 illus.

Spot-Weld Joint Efficiency for Aluminum Alloys. C. W. Steward. A paper reporting the major results of a study of the factors that contribute to both high- and low-joint efficiency of multispot joints used for splicing sheets of aluminum alloy together. Each step in the study is explained, and the tests applied are described with details on the samples tested. It is emphasized that the work reviewed covers only a part of the whole study of joint efficiency and that additional phases are planned for future consideration. *The Welding Journal*, October, 1943, pages 528-s–532-s, 12 illus.

Possibilities of Furnace Brazing in Aircraft Production. H. D. Samuel, Jr. It is stated that the recent development, by the Aluminum Company of America, of a method of brazing certain aluminum alloys has induced the aircraft industry to investigate the feasibility of using brazing as a production process in airplane construction.

The brazing of ferrous and aluminum alloys is discussed, and the advantages offered are listed. It is stated that in aircraft production aluminum alloys appear to offer a larger field of usefulness for brazing than ferrous alloys, since they are used more extensively and since production joining methods are not so well established as in the case of ferrous alloys. Most of the development of brazing materials for aluminum alloys has been carried on by the Aluminum Company of America, and so far the process is limited to the work-hardening and the precipitation-hardening alloys. It is noted that a satisfactory technique has not yet been developed for brazing the age-hardening alloys. The strength of brazed joints is discussed. *Automotive and Aviation Industries*, September 15, 1943, pages 28, 29, 64, 4 illus.

Some Definitions of Terms Used in Modern Welding Processes. A. J. T. Eyles. Simple definitions of welding terms are given to assist those engaged in training work. They are not intended to be academically complete but merely to give preliminary accurate names to the processes with which trainees must become familiar. *Sheet Metal Industries*, September, 1943, pages 1609, 1610.

Detailed Instructions and Planned Training Builds Spot Welders. Nate Rekosh. Lists of the requirements for the different grades of workers participating in the training program of the Spot-Welding Department of Consolidated Vultee's Miami Division are given. They are classified under the following headings: what spot-weld trainees must know; what spot-weld trainees must do; what a Class A spot welder must know; what a Class B spot-weld operator must know; and what a Class B spot-weld operator must do. As an example of the tables of approximate setups attached to each spot-welding machine to guide the operator, a table for the Type PMCO Sciaky 0.25 machine is shown. It gives complete data, tabulated by thicknesses of the sheets to be combined in any given welding operation. *Wings*, September, 1943, pages 662, 663, 1 illus.

Low Temperature Joining for Production and Repair. Robert S. Burpo, Jr. An investigation of the series of so-called "low-temperature welding" (Castolin Eutectic) alloys introduced to the American market in the few years. It is noted that certain of these weld-rod materials are claimed to produce joints as strong as conventional fusion welding but at a temperature down in the brazing range where distortion and unwanted tempering can be minimized. The writer investigated these materials by obtaining data, experience records, working methods, and opinions of their utility directly from the plants that have been using them. The subject is discussed under sections covering the fields of application, welding aluminum castings, reclaiming broken tools, and joining production ordnance parts. The conclusions of the survey are listed. *Metals and Alloys*, September, 1943, pages 513–517, 5 illus.

Cyclewelding Applied Successfully to Airplane Subassemblies. An article on cyclewelding, the process for bonding metal to metal, wood, rubber, or plastic. It is stated that the process has been so developed and improved that it is now being used by a number of manufacturers for uniting aircraft parts, including the production of wing flaps, ski pedestals for gliders, fiber and wooden gasoline tanks, certain structural sections of bombers, and numerous other parts. Development of the Cycleweld method, based on a specialized cementing technique, was directed by S. G. Saunders, Production Research Engineer of the Chrysler Corporation, who had the cooperation of the Army Air Forces Matériel Command in Dayton and the Navy Bureau of Aeronautics in Philadelphia. *Automotive and Aviation Industries*, October 1, 1943, pages 33, 94, 2 illus.

Modern Methods in Aircraft Welding. Nairne F. Ward. It is noted that all welding processes used in aircraft production may be classified as fusion welding or pressure welding, with their subdivisions as shown by a chart. The various welding methods, procedures, and techniques are discussed in some detail. Testing and inspection methods are outlined. Illustrations include a chart showing typical combinations of metals applicable to resistance welding, a sample spot-weld job-analysis card, and a typical spot-welding machine-maintenance log. *Mechanical Engineering*, October, 1943, pages 732–736, 7 illus.

Another MARTIN USA Martin First

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Engines start instantly in sub-zero weather

. . . *thanks to this new* Martin lubrication system

WHEN radio warns of approaching enemies instant starting is required . . . and instant starting in sub-zero weather is now possible on U. S. planes, through Martin's newly-developed cold-weather lubrication system. Vital to victory today, this new device holds great promise as a means of starting automobiles, trucks or tractors on bitter-cold mornings. Here's how it works.

Without the Martin Method

Oil for an airplane engine is kept in a tank, not in the crankcase. A compartment within the tank lets some of the oil warm up faster than the rest so that it gets to the proper running temperature quicker. An oil cooler between the engine and tank keeps the oil from getting too hot. Pilots, landing in cold weather, press a button which introduces gasoline into the oil so that when they start the motors later the cold oil will be thin and permit a quick take-off. However this gasoline often evaporates from the hot engine, the oil is not thinned properly and when the engine is started, the oil cooler is blown up by the thick oil being forced into it. Result—disaster.

With the Martin Method

To meet this problem, Martin engineers devised the new lubricating system which:

1. Injects the diluent into the oil after it has passed through the engine. This prevents the hot engine from evaporating the diluent leaving the system filled with thinned oil.
2. The new system utilizes a by-pass to prevent cold, hard oil from blowing up the oil cooler.
3. The Martin system permits dilution with dual return lines to the oil tank, one line leading to the warmup compartment, the other to the main section of the tank.
4. With the Martin system, the diluted oil is returned to the warm-up compartment, thus avoiding dilution of all the oil in the tank.

Result—mission accomplished!

Proved in action, on Martin and other planes, the new Martin lubrication system has solved a major problem of global warfare—has brought added safety and efficiency to U. S. aircraft—and has opened new vistas for peacetime industry. In war or in peace, keep your eye on the Martin star.

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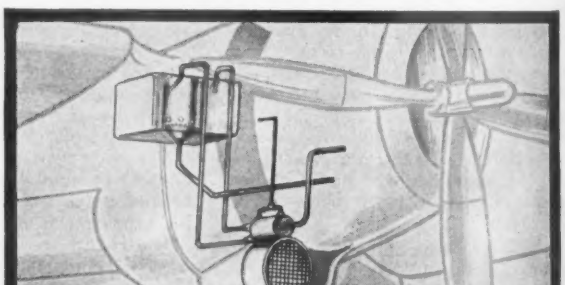
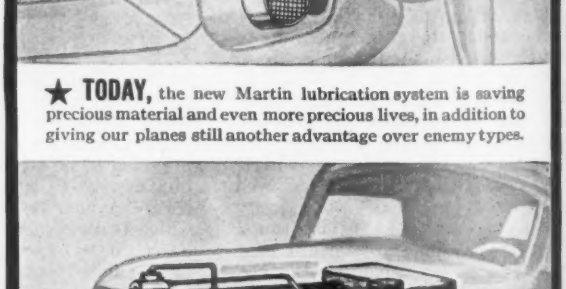


★ **TODAY,** the new Martin lubrication system is saving precious material and even more precious lives, in addition to giving our planes still another advantage over enemy types.



★ **TOMORROW,** the Martin method will mean much, not only to commercial airlines, but also to manufacturers and owners of trucks, tractors, buses and private automobiles.

Government Publications

Army Air Forces

Beware the Pacific Thunderhead. Lt. Col. James Connally. Some observations on flying through fronts dominated by thunderstorms in the Pacific area. Although it is stated that no set rules can be established, suggestions for penetrating tropical storm areas are advanced. One technique is by placing the flying formation in a column of elements and having an experienced leader select "light" spots in the clouds by which he can pick his way around and between the thunderheads. Over water, it is claimed that this method can be used effectively at times by flying 100 to 200 ft. above the surface. Another technique advised for flying at a 100-ft. altitude over water is based upon the employment of a shallow echelon flying well forward, with about a 2-mile interval between planes. *Air Force*, October, 1943.

This Is Your Enemy . . . It's Your Life or His! The introductory portion of this article is concerned with a description of air-to-air bombing tactics employed by the enemy to break up tight flying formations of Allied bombardment planes. The rest of the article consists of brief paragraphs containing data on various enemy tricks as well as incidents characteristic of the Germans, Italians, and Japanese. These are headed by the following titles: decoy methods; loaded purse; night flares; the jumping Italians; rag mine; hot water; cushioned landing; guiding light; construction camouflage; night airdrome defense. *Air Forces*, October, 1943.

How to Keep Well in the Italian Theatre. Brig. Gen. David N. W. Grant. Notes from the Air Surgeon's Office contain advice on health precautions to be taken by American troops fighting in the Italian area. The suggestions refer to safeguards to use before eating fruits and vegetables or drinking water and milk; against malaria-bearing mosquitoes, dengue-bearing mosquitoes, and other disease-carrying insects; for prevention of veneral diseases. *Air Force*, October, 1943.

Armament Developments. The Armament Laboratory at Wright Field has issued a report on new developments in aircraft armament for both defensive and offensive use. Among the advancements that have been completed in aircraft fire power since the first World War are: (1) development and improvement of the high cyclic rate small-caliber machine guns, the most important of which is the 0.50 caliber gun and aircraft cannon; (2) new electric and hydraulically controlled fire-control systems, remotely controlled and locally operated multiple machine gun turrets, and fire-controlling devices such as so-called computing sights now responsible for so many enemy airplane casualties; (3) practical application of new and unerring bombsights and allied equipment; (4) the 20-mm., 37-mm., and larger-caliber aircraft cannon; and (5) bomb racks, shackles, release mechanisms, etc. It is stated that all of these items were developed and perfected by engineers at Wright Field with the cooperation of various commercial manufacturers.

An unusual view of the Thunderbolt fighter shows four of the eight 50-caliber machine guns. Note the four-bladed propeller.

In addition to the power turret, other comparatively new devices mentioned are the chute-type ammunition feeder and a new shell ejection system. Protective armor has received much attention and improvements are being made continuously. *Army Air Forces Matériel Command.*

In accordance with the newly formed policy to return to industry immediately all items or material that are needed by private industry working under Government contract, the Commanding General, Army Air Forces, has caused to be established a Disposal Depot at Memphis, Tenn. After reviewing specific requirements at Army Air Forces Headquarters for a specific period, all excess equipment is concentrated at the Disposal Depot. Included in this concentration are the following: (1) items that are currently being manufactured for assembly into equipment on existing contracts; (2) items that by a slight modification could be utilized on current contracts; (3) processed material for production aids; (4) Army and Navy standard parts and aircraft hardware; (5) strategic materials that could be recast for specific requirements; (6) accessory manufacturers items; (7) items originally produced by one manufacturer and not needed by him, but possibly could be utilized by another war contractor; (8) commercial hardware items; (9) tubing in random lengths of which, by removing the formed portion, the straight section can be utilized; (10) material, while not directly contributing to the war effort, that can be applied to strategic requirements for domestic use.

This Depot has been authorized to contact and negotiate through its contracting officer resale of above referred items to manufacturers, contractors, and to their suppliers currently supplying equipment for the prosecution of the war. A catalogue of excess materials is being distributed. *830th AAF Specialized Depot.*

Army-Navy-Civil Committee on Aircraft Design Criteria

ANC Handbook on the Design of Wood Aircraft Structures. This handbook has been prepared by the Forest Products Laboratory of the U.S. Department of Agriculture and the Army-Navy-Civil Committee on Aircraft Design Criteria, for use in the design of both military and commercial aircraft. It contains material that is acceptable to the Army Air Forces, the Navy Bureau of Aeronautics, and the Civil Aeronautics Administration, but methods and procedures other than those outlined are also acceptable provided they give equivalent results or provided they are properly substantiated. The book has previously been in the restricted class but has recently been released.

The technical material is contained in Chapters 2, 3, and 4 and pertains to three related phases of the structural design of wooden aircraft. Chapter 2 gives information on the strength and elastic properties of structural elements constructed of wood and plywood and supersedes that contained in the October, 1940, edition of

THEY ALL GET TOGETHER ON THIS

American flyers in the Far East favor one type of fighter plane — the Russians pick another type — the British go for a third — and still a fourth is the special pet of scrappy American birdmen rolling up records around southern Europe and in the Aleutians. ★ All four of these American-built fighters have one thing in common—the Allison engine. ★ And typical of the high regard in which the flyers hold this engine is that of one much-decorated American pilot, who says bluntly, "No engine is more dependable than the Allison." ★ We're glad they feel that way. That is welcome reward for the pains Allison takes — in design, in materials, in workmanship—to achieve peak precision and superfine quality. ★ It is General Motors' purpose to build the best aircraft engine in the world. ★ How well we succeed is a matter best reflected by actual combat results.

POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51A—Mustang

Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AIR
NBC Network

BACK THE ATTACK—
WITH WAR BONDS

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF GM GENERAL MOTORS

ANC-5, *Strength of Aircraft Elements.* Sections of Chapter 2 which are based on incomplete data or theoretic analysis that have not been fully verified by test are so marked in the text as a caution. Those sections that are based on reasonably complete information but which require further substantiating tests are also suitably marked. It is noted that the use of the various formulas and data in those sections should be commensurate with the limitations indicated.

Chapter 3 contains suggested methods of structural analysis for the design of various aircraft components. Although these methods are in many cases the same as those used for metal structures, special considerations have been introduced which take into account the orthotropic properties of wood.

Chapter 4 gives recommendations on the detail structural design of wood aircraft and contains some examples of how various manufacturers have treated the solution of specific design problems.

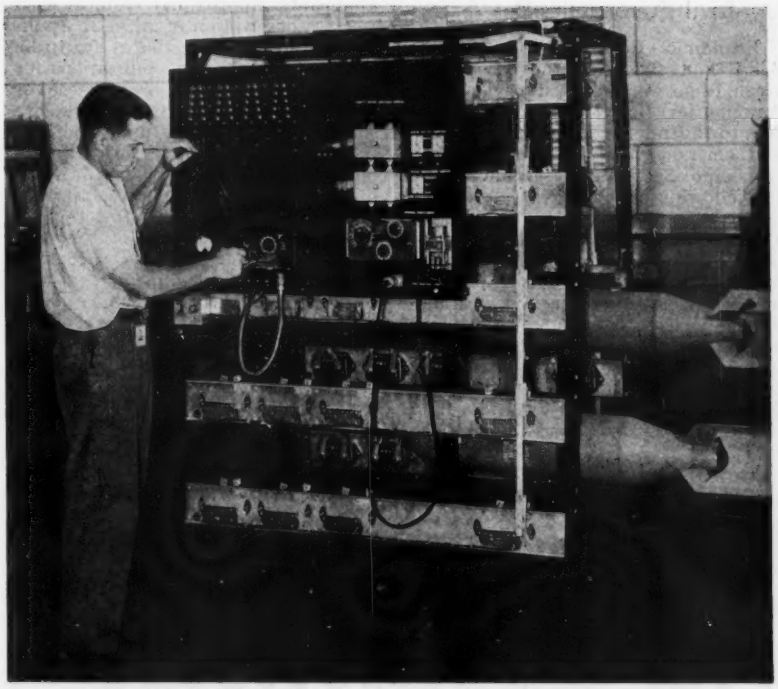
Civil Aeronautics Administration

Survey of the United States Overseas Mail Service is a 47-page brochure. In the opening pages a summary of the survey is given and the conclusions formed are outlined. General observations on the origin, volume, trends, seasonal variations, cost of sea transport, and foreign distribution of overseas mail are set forth. Appendices contain charts, maps, data tables, and other information connected with the analysis.

Civil Aeronautics Manual 60, covering Air Traffic Rules, has been amended as of August 1, 1943, and is for sale through the Superintendent of Documents, Washington, D.C. It is a supplement to Part 60 of the Civil Air Regulations. It is published in simplified form and deals only with those sections of Part 60 which pertain directly to air-traffic control. It outlines, in easily understandable form, the procedures and phraseologies for both airport and airway traffic control. While these procedures and phraseologies are not regulations in themselves, they have been set up as recommended practices that will provide for safety in the operation of aircraft.

Instrument Approach Performance Characteristics on Radio Instrument Landing Systems. The results given in this report involve data that were obtained originally in connection with a study of aircraft take-off and landing characteristics, conducted during the latter part of 1938, and the correlation of those characteristics with airport size.

Photographic space-time records of the approach paths followed by a DC-3 airplane in making 25 instrument landings with the pilot under the hood were obtained at the Oakland, Calif., municipal airport. The Bendix-type radio instrument landing equipment (equi-signal localizer and constant intensity glide path) was used in all these landings.



This bomb rack enables Matériel Command armament engineers to study different types of release mechanisms. (See page 129.)

The results are presented as curves showing the vertical and horizontal projection of the flight paths, air speeds, and sinking speeds from 100 ft. above the ground to and through contact, including the first few hundred feet of ground roll. Curves involving each individual approach, as well as envelopes of all the approaches, are reproduced. *Technical Development Report No. 32,* June, 1943.

Domestic Air Carrier Operations Statistics for the Year 1942. Statistics on domestic air-carrier operations for the year 1942 have been published. Tables cover a comparison by six-month periods of the years 1942 and 1941; operations by air-line routes; operations by months; domestic air-carrier operations statistics for the month of June, 1943; and domestic air-carrier operations statistics for the first six months of 1943, as compared with the same period for 1942. *Civil Aeronautics Journal,* September 15, 1943.

Life Tests of Electric Discharge Lamps. A report has been issued on the results of a study of the cold-cathode electric discharge lamps used in approach lights. The primary purpose of these tests was to increase the useful life of the lamps and thereby reduce the cost of maintenance. To this end, measurements of the effects of varying the voltage, gas pressure, and other characteristics affecting the life and light output were made. Possible modifications of the specifications, and accelerated life tests are considered. *Technical Development Division, Washington, D.C., Note No. 29,* May, 1943.

Gain in Field Strength of Four Symmetrically Disposed Antennas Compared to One Antenna. An analysis is made of the obtainable root mean square field strength in the horizontal plane with a given radio-frequency power fed into four identical, short vertical antennas which are located in the corners of a square. This field strength is compared to that produced with the same power fed into a single antenna of the same design. The resistance coupled into each antenna by the other three is computed.

A formula giving the gain in field strength for four antennas over that obtained from one antenna is derived, and families of gain curves are plotted.

The theory presented is stated to be in essential agreement with measurements of gain in field strength made at the Pittsburgh, Pa., radio range. A gain in field strength of the order of 1.8/1 can be realized at the lower frequencies. The gain increases as the coil and ground resistance of the antenna circuit becomes greater, and it also increases as the antenna spacing is reduced. *Technical Development Division, Note No. 28,* October, 1942.

Civil Aeronautics Board

Economic Regulations. Sections 238.1 and 285.4 of the Economic Regulations were adopted by the Civil Aeronautics Board without circulation to the industry because of special and emergency circumstances. The revision of Section 238.1 accomplishes the following changes: (1) Service of notice by applicants for Certificates of Public Convenience and Necessity is no longer required. Notice to the public of the filing of an application will be given by the Board by posting notice of each application in the office of the Secretary and by making the information available to the press. In addition, the Docket Section will distribute to a mailing list including all of the existing air carriers and other applicants, approximately once each week, a description of all. (2) Applications for domestic routes are to be filed separately from applications for authority to engage in overseas or foreign air transportation. Although such applications may upon occasion be consolidated for hearing, the requirement of separate applications distinguishes between those applications that are, and those that are not, affected by Section 801 of the Act. (3) Maps attached to applications no longer are required to include existing service by other air carriers to points involved in the application.

The revision of Section 285.4 changes the time for accomplishing formal interventions. Hereafter intervening petitions may be filed at any time prior to the first prehearing conference or, if there is none, not later than 10 days prior to the hearing. *Civil Aeronautics Regulation, Serial Numbers 284 and 295*, August, 1943.

Section 251.2 of the Economic Regulations was made effective October 11, 1943, requiring that every air carrier shall file with the Board specified evidence of each agreement affecting or involving operating rights as between such air carrier and any foreign country or political subdivision thereof. The regulation prescribes the form and scope in which the evidence is to be submitted and the time of filing. *Civil Aeronautics Regulation, Serial Number 286*, September, 1943.

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MEET GOVERNMENT SPECIFICATIONS IN THE AIRCRAFT INDUSTRY

Aeronautical Board

Wood Aircraft Fabrication Manual. This manual was prepared by the Forest Products Laboratory of the United States Department of Agriculture and issued by the Aeronautical Board for the use of the Army Air Forces, the Bureau of Aeronautics, and the Civil Aeronautics Administration. It has been in the restricted class until its recent release.

The specific purpose of this publication is to provide information that will assist the manufacturer of wood airplane parts in preparing materials and carrying out the operations essential to producing modern planes and parts in accordance with specifications and drawings.

It is intended for woodworkers skilled in the building of wood aircraft as well as those unfamiliar with such construction. It should be of assistance to the aircraft designer by adding to his knowledge of the operations and procedures involved in forming and assembling wood and plywood parts. It should be of further assistance in defining the requirements of materials for specific parts and in using them efficiently, thereby conserving high-grade and critical materials.

This publication does not purport to contain all the information about wood and related materials which is of interest to the airplane designer or fabricator. For additional information on specific topics frequent references are given to other publications.

Army-Navy Aeronautical Standards. New and revised Army-Navy Aeronautical Standards sheets have been issued, covering the following classes of equipment: nuts and screws of various types, light assemblies, adapters, couplings, lamps, soldering terminals, clocks, navigation drawing sets, manifold-pressure gauges, wheel and flap position indicators, portable oxygen recharger assemblies, hydraulic pressure accumulators, hydraulic filters and filter elements, life-raft sails, hydraulic bleeder-valve, and accumulator installations. Landing and auxiliary wheel-rim contours are also covered. *Working Committee of the Aeronautical Board.*

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-50 °C +150
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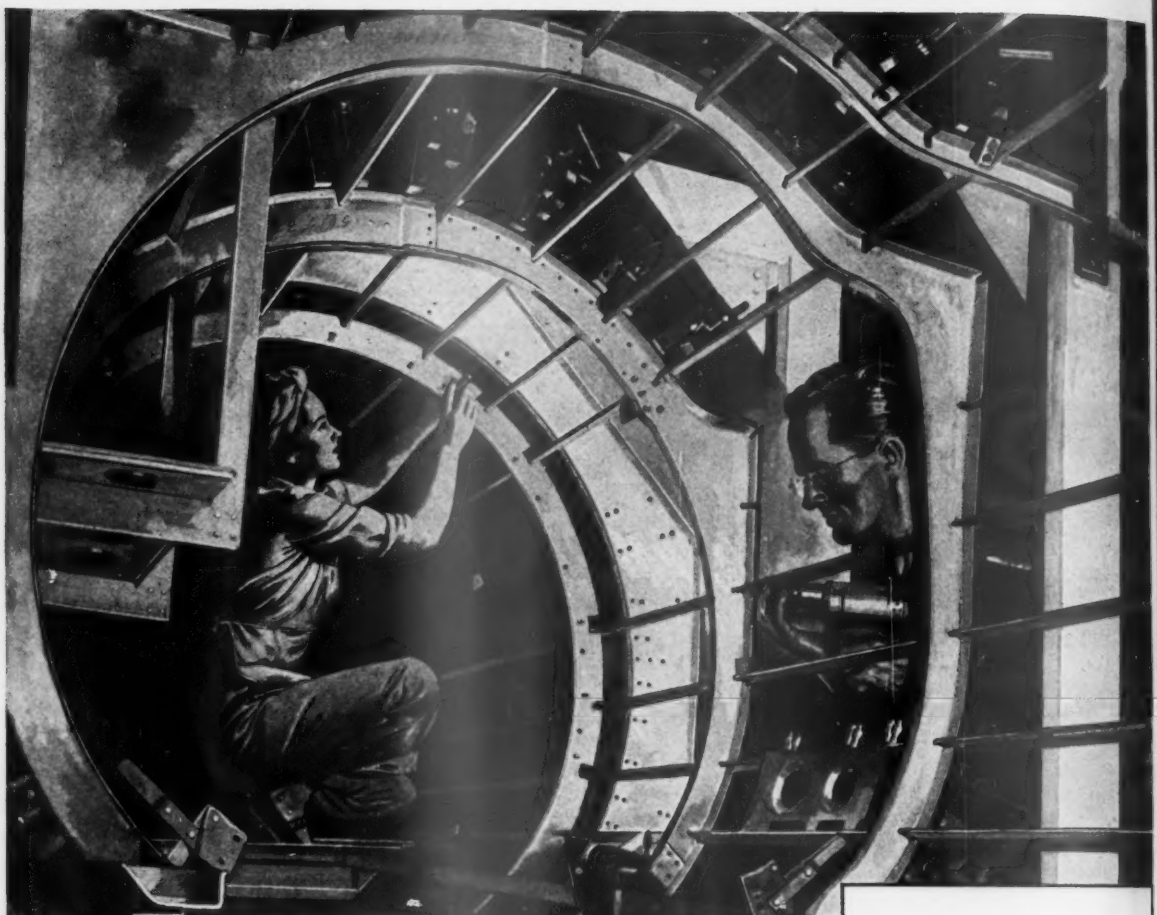
AIRCRAFT INSTRUMENTS



What is happening at Northrop today will help bring Victory sooner

'WAY BACK IN 1930...there was an airplane called the Northrop "Alpha"... the first all-metal stressed-skin monoplane to embody the multicellular wing structure.

The "Alpha" is important to America. It ushered in the era of the modern low wing all-metal monoplane.

Thereafter, the Northrop group created the Northrop "Gamma"—first airplane with the now-familiar split trailing edge landing flaps. Faster, even more aerodynamically "clean" than the "Alpha", the Northrop "Gamma" set trans-continental air-mail records. With military modification, ***the "Gamma" became the world's first airplane to be used as an attack bomber.***

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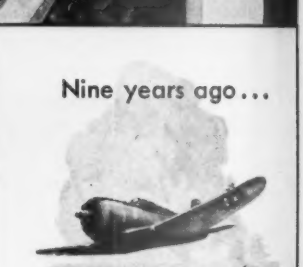

In 1934, the Northrop group designed and built the Northrop 3A, pioneer of fighters flying over 300 miles an hour. To this low wing pursuit with its clean lines, retractable landing gear, and split trailing edge landing flaps may be traced the ancestry of many of today's fighters.

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BOOKS

Books reviewed in this section may be borrowed without charge from The Paul Kollsman Library, Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York 20, N. Y.

Prepare for the United States Air Forces Tests

William K. Vilmos

Sections: Do You Want to Enlist in the Army Air Forces! Physical Aptitude Tests in the Army Air Forces; Aviation Cadet Training for the Army Air Forces; Your Job in the Army Air Forces; What Types of Planes Will You Fly in the Army! Do You Have Sound Judgment! Do You Know the Meaning of Words! Do You have Mechanical Aptitude! How are You Posted on Current Events! Can You Read Intelligently! Do You Know Aviation Mathematics! Essential Aviation Terms and Definitions.

Many a young man with an ambition to become a cadet wonders why an educational background is required. This book will enable him to learn broadly and specifically what a cadet has to know before he is acceptable for pilot training.

The tests that have to be taken by the candidate, both physical and mental, are carefully explained. Even though the requirements have been lowered since the war started, they are still sufficiently difficult to provide an obstacle to be overcome only by study.

The physical aptitude tests may only be learned after examination by flight surgeons and instrumentation, but the mental equipment required may be gauged by the examinations given in the book. By the method adopted by the Air Forces of questions and choices of answers, any young man can soon determine whether or not he has the mental training to pass the examination.

The tests indicate the soundness of a man's judgment, his understanding of words, his mechanical aptitude, whether he is posted on current events, and his ability to read instructions intelligently. A knowledge of simple mathematics is required, as well as an acquaintance with equations and formulas. Graphs, scales, and maps have to be understood and interpreted.

The book is based on the requirements of the Aviation Cadet Examining Board and gives a preview of the kinds of examinations an applicant will have to pass. Familiarity with the methods of testing will make them easier to understand. Capitol Publishing Company, New York, 1943; 144 pages, $1.50.

Aerial Warfare

Hal Goodwin

Chapters: Aerial Warfare; The Bomber; The Heavy Bomber; The Bombing Crew; The Medium and Light Bomber; The Dive Bomber; The Patrol Bomber; The Torpedo Plane; Bombs; The Fighter Plane; Fighters in Action; The Aircraft Carrier; Specialized Wings; Armor and Armament; Aircraft Engines; Stratosphere Flight; Parachutes and Paratroopers; Air Transport; Lighter-Than-Air Craft; Aerial Weapons of Tomorrow.

This book gives a clear idea of the various types of airplanes used in aerial warfare. It not only describes the function of the different sizes of bombers, fighters, and torpedo planes, but it outlines the work of their crews and the armament carried. The characteristics of the principal military and naval airplanes are given, with the uses to which they have been put in the war.

The roles of the aircraft carrier and specialized projected types of aircraft are explained. Armor and armament, parachutes and paratroopers, and lighter-than-air craft have their chapters.

The remarkable expansion of the use of cargo planes for air transport in time of war and the aerial weapons of the future bring the book up to the present state of thought in military aviation.

Interspersed are stories of the use of the air weapon in particularly heroic actions of the present war. The New Home Library, New York, 1943; 273 pages, $0.69.

Canada's War in the Air

Leslie Roberts

Chapters: The War Drums Roll; The Birth of the Air Plan; The Organisation Period, 1939–1940; The Plan Goes into Mass Production; The Making of an Airman; Canada's Construction Men Do the Impossible; The Third Year Ends; The Plan in Full Stride.

An encyclopedic volume of the great effort of Canada in creating an air force and an aircraft industry to prove its worth during World War II. With a wealth of pictorial material, the compilers have given detailed descriptions of every phase of aviation development in the Dominion.

Starting with a history of Canadian aviation in World War I and the inevitable slump in aeronautical interest until 1939, the reader is taken into the organization period of the present expanded program and on through to its ultimate mass production of pilots, airplanes, and airports. The story of the training of the pilots of the Royal Canadian Air Force and the coordination of industrial power to fulfill the requirements of the training program and the construction of wartime aircraft is, as the author states, a recital of the accomplishment of the impossible. Now that the plan is in full stride an overall view of the magnificant achievement can be seen.

As the author says in his foreword, the book tells "the glamorous story of the biggest job ever done in Canada—the creation, organization, and bringing into production of that far-flung force of men and machines which constitute the British Commonwealth Air Training Plan and the battle squadrons that are its result. With it is coupled a bird's-eye view of Canada's Miracle Industry and its people—the men and women who have made this young nation the greatest aircraft producer, per capita, of the democratic world." Alvah M. Beatty Publications Limited, Montreal, 1943; 100 pages.

Southern California Aircraft Industry Job Evaluation Plan for Shop Occupations

This comprehensive and detailed study of shop occupations in the Southern California aircraft industry standardizes the jobs under three degrees of skill and experience and shows the maximum and minimum pay for each classification. The qualifications for each job are considered on the basis of mentality, skill, responsibility for material and equipment, mental application, work conditions, physical requirements, and hazards.

Each job is analyzed under the foregoing headings for the three groups, so that workmen can be rated according to their qualifications. The plan represents the results of experience of seven aircraft companies and will provide a useful guide for all other companies in the aircraft industry. The orders that were issued by the West Coast Aircraft Committee and approved by the Tenth Regional War Labor Board are appended. Southern California Aircraft Industry, Los Angeles, 1943.

The House of Goodyear

Hugh Allen

Chapters: Economic Heresies and Modern Business; A History of the Company; Materials: Rubber and Cotton; Products: Tires; Expansion: in the United States and Overseas; Industrial Relations; Distribution; Defense Demands on Industry.

Although earlier editions of this book were published in 1936, Hugh Allen has revised and brought the history of this industrial pioneer up to the present. The historical section is of the greatest interest, since it shows how Frank Seiberling's courage and ability brought about the company's growth from 1898 to 1920.

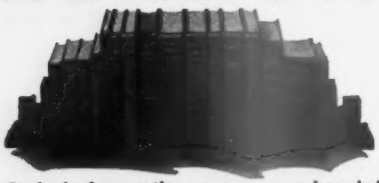
From there on it is a tribute to the engineering genius and broad vision of Paul W. Litchfield. He led in the innumerable new activities undertaken to expand the base of the company.

Not the least of Litchfield's pioneering has been in lighter-than-air aeronautics and, during the present war, in the manufacture of aircraft. Starting with balloons and later with blimps and nonrigid dirigibles, the Goodyear development proceeded to the building of the Zeppelin type. The book is really a history of American lighter-than-air progress. Alongside this work was the production of the many rubber products used in airplanes, particularly tires.

When the ban was placed on the sale of tires for private automobiles, Litchfield turned to the manufacture of airplane parts and later to the production of complete airplanes.

No one can read of the progress made by the Goodyear company in industrial relations and foreign undertakings without a feeling of pride in the ability of an engineer to grasp opportunity when private enterprise was the motivating force of industry. Goodyear Tire & Rubber Company, Akron, O., 1943; 417 pages.

WILEY BOOKS *in* AERONAUTICS



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These two volumes cover the analysis of welded tube structures, wooden beams and members, and all-metal or stressed-skin structures. They offer practical design information sufficient to solve the more common problems of the aeronautical structural engineer.

2) THE AIRPLANE AND ITS COMPONENTS
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3) AIRPLANE STRUCTURAL ANALYSIS AND DESIGN
By Ernest E. Sechler and Louis G. Dunn
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This book summarizes briefly but intensively the portions of aerodynamics needed by the aeronautical engineer, with particular emphasis on fundamental principles of fluid mechanics.

5) AIRCRAFT ENGINE MAINTENANCE
By James H. Suddeth
374 PAGES 269 ILLUSTRATIONS $2.75
Shows just what steps to take in handling any overhaul job. It is up-to-date, reliable, and a source of quick, first-hand information.

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Second Part, Experiments. Chemical Conditions of the Death of Animals Subjected to Different Barometric Pressures in Closed Vessels; Gases Contained in the Blood at Different Barometric Pressures; Phenomena Presented by Animals Subjected to Pressures Less Than One Atmosphere; Action of Compressed Air on Animals; Influence of Changes in Barometric Pressure on Plant Life; Action of Changes in Barometric Pressure on Ferments, Poisons, Viruses, and Anatomical Elements; Effects of Sudden Changes in Barometric Pressure; Various Questions.

Third Part, Recent Data, Summary and Conclusions. Decreased Pressure; Increased Pressure; General Conclusions.

Because copies of the original French edition of this classic of altitude physiology are exceedingly rare, an English translation from the French has been published. The purpose of the present edition is to make available to English-speaking people the great store of fundamental information, originally published in 1878, which is considered as the foundation of modern research on the effects of varying atmospheric pressures on the human body.

The book is divided into two main parts and numerous titles, chapters, and subchapters. The first part deals with the history of altitude physiology up to the time of publication. The second part contains detailed descriptions of many experiments and of the apparatus used. The third part gives the author's summary and conclusions, with his comments on recent developments and practical applications.

The translators have been careful to adhere as closely as possible to the original text, even to the point of retaining words and phrases that are now somewhat outmoded in the language of modern science. This was done purposely, because of their respect for the author's distrust of translations and to preserve

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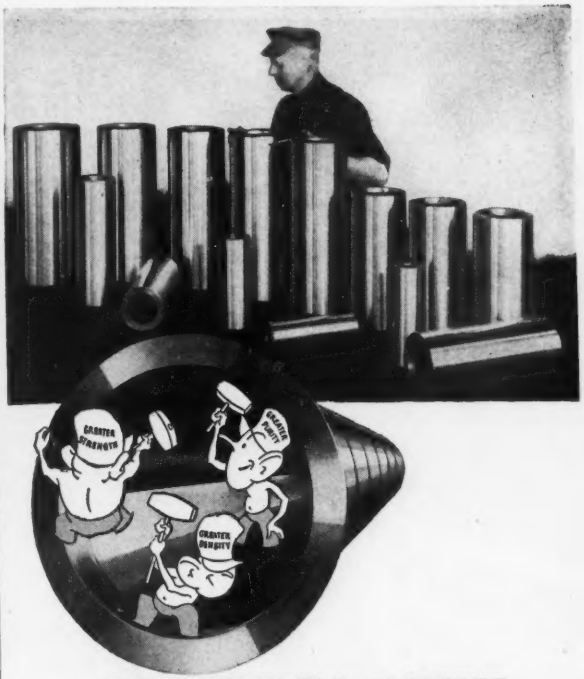

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PROTECTING THE "Nerve Center" OF A B-25 BOMBER

The young lady is attaching terminals to the panel of an electrical junction box, shortly to become the "nerve center" for a big B-25 bomber. To protect against static interference, incoming and outgoing wiring is encased in Flexible Low-Tension Shielded Conduit made by American Metal Hose.

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his meaning. In two respects they have departed from the plan followed in the French edition. First, the footnotes have been grouped together at the end of several chapters instead of being placed at the bottom of the page on which the reference occurs; second, they have added an index. College Book Company, Columbus, O., 1943; 1055 pages, $12.

Air Navigation

Chapters: Part I—Introduction to Earth; Geography of Axis Strategy; United Nations Supply Lines; Strategy of the Arctic; Key Objectives of Economic Importance; Key Objectives of Locational Significance; Climates of the Oceans; Climate and Weather in Selected War Zones.

Part II—The Earth; Maps, Charts and Projections; Plotting Sheets; Map Reading; Introduction to Time.

Part III—Dead Reckoning Plotting; Lines of Position—Fixes—Radio Bearings; Vector Diagrams.

These are the first three manuals of a series of seven on flight preparation and training. The complete series constitutes the intensified three-month flight preparatory ground school course of the U.S. Navy's Aviation Training Program.

Part I, Introduction to Earth, has been prepared for the purpose of orienting naval aviation cadets to the study of navigation. It gives an overall view of the earth as a sphere, place relationships of war zones, general climatic considerations underlying strategy, and something of the strategic significance of military objectives.

Part II, Introduction to Navigation, covers the basic fundamentals of navigation technique. It includes a detailed explanation of the various types of map projections, a knowledge of which is essential for piloting courses.

Part III, Dead Reckoning and Lines of Position, introduces some basic applications of the fundamentals covered in the first two volumes. It explains how the aerial navigator records the progress of his plane over the surface of the earth. It describes certain methods used to check the estimated position of the plane during flight, and the manner by which the effects of air currents on the movement of a plane can be determined. McGraw-Hill Book Company, Inc., New York, 1943; Part I, 79 pages, $1.00; Part II, 81 pages, $1.00; Part III, 77 pages, $1.00.

Metal Forming by Flexible Tools

Chris J. Frey and Stanley S. Kogut

Chapters: Press Equipment; The Rubber Die; Forming; Flanging; Spring-Back; Blanking; Types of Drop Hammers; Die Manufacture; Hammer Operation; The Power Brake.

Modern methods of metal forming by means of flexible tools, as applied to the high-speed production of aircraft, are set forth in this book. Information is given on improved methods of forming sheet-metal parts accurately, quickly, and with a minimum of expense. The broad industrial applications of flexible tooling are outlined. The authors discuss the rubber press, drop hammer, power brake, and stretch press. Forming operations, dies, die materials, and the operation of the drop hammer and power brake are described.

An appendix contains data on the classification and nomenclature of aluminum. Pitman Publishing Corporation, New York, 1943; 193 pages, $3.00.

Aircraft Identification for Fighting Airmen

Squadron Leader G. E. Wilso

Because the author found students have difficulty in visualizing aircraft in various positions from two-dimensional black and white silhouettes, finished perspective drawings of aircraft are shown in this book. These drawings accentuate the most important recognition features of planes from each angle. The book contains over 500 special drawings that emphasize in proportion and shading over 1,500 characteristics of the most important types of aircraft in the syllabus of training in the Royal Canadian Air Force. Each plane is described and illustrated in a double-page spread. There are also 52 photographs of planes in action for use as identification tests. This American edition includes drawings of Japanese planes. David McKay Company, Philadelphia, 1943; 192 pages, $1.50.

Technique of Production Processes

John Robert Connelly

Chapters: Casting; Forming; Material Removal; Joining; Material Handling; Stores; Plant Services; Product Standardization and Gaging; Methods Study and Job Study; Equipment Operation; New Equipment.

The object of this book is to give the student a background knowledge of the elementary principles of industrial operations, such as casting, forming, material removal, and joining, together with an understanding of industrial plants and their problems. The course covers study in this field up to the level of advanced specialized work. While a knowledge of the underlying sciences is presupposed, the book is intended to be useful in familiarizing the student who lacks such knowledge with the basic problems and processes. McGraw-Hill Book Company, Inc., New York, 1943; 430 pages, $2.75.

Fogs, Clouds and Aviation

W. J. Humphreys

Chapters: Evaporation and Condensation; Fogs; Cloud Forms; Cloud Miscellany; Cloud Splendors.

Written for those who require a fuller account of fogs and clouds than is given in general works on meteorology, this book contains scientific explanations of such atmospheric phenomena in simple, easily understood language. The book is intended particularly for those who are teaching and studying meteorology in connection with aviation. Information is given on the significance of the various types of fogs and clouds; how thin, extensive, how high and opaque they are; whether they provide fair or excellent one-way screens in combat; and what the danger of icing is. Many photographic reproductions of cloud formations are shown. The Williams & Wilkins Company, Baltimore, 1943; 200 pages, $2.00.

Stress Analysis for Airplane Draftsmen

Ernest J. Greenwood
and Joseph R. Silverman

Chapters: Design Loads on Airplanes; Statics; Properties of Materials Used in Airplane Design; Simple Tension, Compression, and Shear; Proportioning of Connections; Centers of Gravity and Moments of Inertia; Beam Theory; Design of Members under Tension and Compression; Round Tubes in Torsion; Spring Theory; Hoop Tension; Fatigue, Stress Concentrations, and Combined Stresses.

To furnish the background of structural information which a draftsman should have in order to be a successful airplane designer is the aim of this book. The book is not written for those who intend to follow structural design as a profession. It is intended to furnish information that will enable the draftsman to deal with everyday airplane structural design problems that can be solved by an elementary knowledge of stress analysis. Aeronautical stress analysis is divided into three major phases: the determination of the loads on the structure; the determination of the resulting stresses in the members; and the investigation and comparison of types of construction suitable for carrying these loads and stresses. Each of the three phases of stress analysis is presented as required for the solution of the problems. Both the authors are engineers of the Chance Vought Aircraft Division of the United Aircraft Corporation. McGraw-Hill Book Company, Inc., New York, 1943; 291 pages, $3.00.

Studies in Arc Welding

Sections: Automotive; Aircraft; Railroad; Watercraft; Structural; Furniture and Fixtures; Commercial Welding; Containers; Machinery.

The volume contains 98 papers on arc-welding design, manufacture, and construction selected as outstanding in the 1940–42 Industrial Progress Award Program. The text reflects the intensive application to the welding process during an era in which the United States has taken up the great task of

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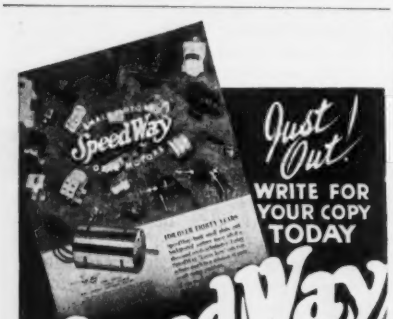

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arming itself and its Allies. Nearly all the papers are reproduced in complete form with regard to both text and illustrations. A few of the lengthy papers have been reduced to pertinent text matter and illustrations.

Papers having to do with arc welding in aircraft include: Welding Aircraft Engine Mounts Economically, by Peter F. Rossmann; Aircraft Propeller Blade, by Elek K. Benedek; Redesign of Airplane Engine Tail Pipe, by Martin Bulger; Arc Welding of Magnesium Aircraft Structures, by Vladimir H. Pavlecka and John K. Northrop; Arc Welding Airplane Boilers, by H. A. Lebert and S. B. Willoughby; Arc Welding of Airplane Parts, by W. S. Evans; Arc Welded Tubular Fuselage, by Alan C. Renn; Welded Airplane Hanger, by Van Rensselaer P. Saxe; Arc Welded Tubular Aircraft Jigs, by Richard H. Holms; and Redesigned 40-Millimeter Anti-Aircraft Gun Carriage, by John D. Miller. The James F. Lincoln Arc Welding Foundation, Cleveland; 1,295 pages, $1.50.

Gas Chemists' Book of Standards for Light Oils and Light Oil Products

V. J. Altieri

A book written for the purpose of explaining simply and accurately the details of current specifications, definitions, tests, and facilities already established in matters relating to light oil and light-oil products. The author's objective has been to give information that will help to speed up production, avoid unnecessary changes in equipment, reduce nonessential demand for strategic or critical materials, facilitate the formulation of new standards, and thus aid the war effort.

The book includes the recent work of W. L. Glowacki on the determination and examination of light oil in gas; J. S. Ball's work on the determination of different types of sulphur compounds; C. C. Ward's review of the literature on the construction, testing, and operation of laboratory fractionating columns; and other material of a similar character. American Gas Association, Inc., New York, 1943; 352 pages.

Chemistry and the Aeroplane

Vernon J. Clancy

Chapters: Making Flight Possible; Petrol; Substitute Fuels; Petrol plus Engine; Steel; Non-Ferrous Alloys; Plastics; Chemical Energy; The Gas Laws; Behaviour of Gases; Accessories.

A book written for the purpose of providing a link between the chemical theory presented in textbooks and the practice of flight. To accomplish his objective the author has found it necessary to incorporate in the text a little theoretic organic chemistry, physical chemistry, metallurgy, and other subjects in order to deal with such topics as fuels, plastics, and the metals used

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in the field of aviation. It is assumed, however, that the reader will have some knowledge of chemistry. The book shows that the role of chemistry in the development of the airplane is a part of a general dynamic process.

This book is one of Nelson's Aeroscience Manuals, a group of individual treatments covering each of the sciences underlying aeronautics. The Ronald Press Company, New York, 1943; 176 pages, $2.25.

Aircraft Electrical Engineering

Randolph Matson

Chapters: Drawing Practice; Wiring Diagrams; Wiring; Power-Supply Systems; Power-Plant Electrical Equipment; Electric Motors and Power Drives; Lighting; Miscellaneous Electrical Equipment; Conduit and Open Wiring; Junction Boxes; Bonding and Shielding; Radio; Instruments.

Written by the executive engineer of the Oklahoma City plant of Douglas Aircraft, this book is designed to meet the need for a text for those courses in aircraft electrical engineering which prepare the student as directly as possible for activities in the electrical group in the engineering departments of aircraft manufacturers. Since many books are available on general electrical theory and electrical engineering, particular attention is given in this book to the latest developments in electrical engineering as applied to aircraft. Because radio and instrument installations are usually assigned to the electrical group, chapters on each of these are included. In addition to its function as a text, this book is intended to be helpful as a reference for those actually engaged in the fabrication of aircraft electrical installations and related activities, as well as those responsible for designing electrical equipment for use in airplanes. McGraw-Hill Book Company, Inc., New York, 1943; 372 pages, $3.00.

Book Notes

Makers of Modern Strategy, edited by Edward Mead Erle, Princeton University Press, Princeton, N. J., 1943; 353 pages, $3.75.

This encyclopedic review of the strategic concepts since the time of Machiavelli gives a comprehensive panorama of military and naval thought up to the Nazi concept of war. Edward P. Warner writes an objective chapter on the theories of Douhet, Mitchell, and de Seversky.

The book gives a sweeping view of the development of modern military thought by a symposium of 20 leading historians and analysts of military and naval affairs.

Boot Straps, by Tom M. Girdler in collaboration with Boyden Sparkes; Charles Scribner's Sons, New York, 1943; 471 pages, $3.00.

One of the great leaders of American industry tells the story of his career and the philosophy of business which has brought him success. His rise to leadership in the steel industry is a classic of determination and administrative ability. He gives his side of his clashes with the unions which made labor history.

His entrance into the aircraft industry resulted from his friendship with Victor Emanuel, who took over the Aviation Corporation from E. L. Cord. How the Stinson, Lycoming, Vultee, and Consolidated companies came under a single directorate is told with first-hand knowledge. Personal sketches are given of Victor Emanuel, Harry Woodhead, R. H. Fleet, Mac Laddon, and G. M. Williams. The hopes of Tom Girdler for the postwar readjustment and his confidence in the future for management to achieve success by its ability to bring about a better world make this book more than an autobiography. It is a revealing account of the methods that have given the United States leadership in production.

These Are the Generals; Alfred A. Knopf, New York, 1943; 250 pages, $2.50.

Of the 17 generals whose careers are sketched in this book, Arnold, McNarney, Chennault, Weaver, and Saunders are pilots. Many of the sketches have appeared as articles in magazines, but brought together as a book they give an excellent idea of the men who are leading our military operations in this war.

Report on North Africa, by Kenneth G. Crawford; Farrar & Rinehart, Inc., New York, 1943; 206 pages, $2.00.

This book, written by a newspaper correspondent, gives an interesting picture of the life and politics in Algiers and Morocco during the earlier period of American occupation. He visited several of the airfields and describes the operations of our Air Forces.

Emphasis is on the political intrigues and organization and the leading personalities involved.

Joe Foss, Flying Marine, as told to Walter Simmons; E. P. Dutton & Company, Inc., New York, 1943; 160 pages, $2.50.

The leading Marine Corps ace, with 26 enemy airplanes to his credit, writes not only his autobiography but the story of the work of the Marine fliers at Guadacanal. It is the record of a typical American boy from South Dakota who, through a fortuitous chain of circumstances, found himself in a position where his skill as a pilot and marksman gave him the opportunity to make his name famous. He was given the Medal of Honor by President Roosevelt for his outstanding victories.

The book will show the courage and daring necessary to shoot down the resourceful Japs and will stimulate in the thousands of pilots in training an added effort to perfect their flying technique so that when they engage in combat they will be able to outfly an enemy.

Weather Around the World, by Ivan Ray Tannehill; Princeton University Press, Princeton, N. J., 1943; 200 pages, $2.50.

The author, who has been with the U.S. Weather Bureau for many years, wrote this book for the layman. It emphasizes the weather to be encountered over oceans, which constitute three-fourths of the earth's surface. All of the phenomena associated with weather are explained without the use of technical terms. The special character of weather to be found on each continent is outlined so that the traveler may be prepared for cold or heat, or dry or wet seasons.

Weather in 185 key places is described, making the book useful as a weather guide book. The illustrations are carefully chosen and show the varieties of sky cloud formations which are seen under usual and unusual conditions.

Hand-To-Hand Combat, prepared by the Training Division, Bureau of Aeronautics, U.S. Navy; U.S. Naval Institute, Annapolis, Md., 1943; 228 pages, $2.00.

This manual has been prepared by the officer in charge of the instruction in hand-to-hand combat in naval aviation. Every athletic officer must familiarize himself with all the sports and activities in this training program.

It gives the many forms of attack with fingers, hands, feet, and arms which can be used to disable an enemy. How to disarm and search a prisoner and how at a critical moment an advantage can be gained by what may be termed unorthodox methods of fighting are described. The principle of this form of combat may be expressed by: "He who fights fair is lost."

These Men Shall Never Die, by Lowell Thomas; The John C. Winston Company, Philadelphia, 1943; 308 pages, $2.00.

They Fly for Victory, by Keith Ayling; Thomas Nelson and Sons, New York, 1943; 215 pages, $2.50.

These two books are complementary, as they relate the stories of acts of heroism of pilots. Keith Ayling begins with the outstanding aces of World War I and then describes the famous record flights of the adventurous pioneers of transoceanic flying.

Several famous engineers such as Mitchell, who designed the Spitfire, and Barnwell of the Bristol Company are given credit for the advances made in aeronautic design between wars. In the closing chapters the exploits of the leading aces of the present war are recounted.

Lowell Thomas, while emphasizing the work of the better known Army, Navy, and Marine Corps pilots, also gives, from official records and official photographs, the daring achievements of ground officers as well.

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Both books indicate the important part that airmen are playing in the warfare of today and will preserve for history the imperishable records of heroism that the air has made possible.

Malta Magnificent, by Major Francis Gerard; Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1943; 249 pages, $2.50.

Though this book on the bombing of Malta is an account of what effects resulted from air action rather than the story of the participating pilot defenders, it will always be referred to as the classic example of the successful resistance of an island which the Germans called the island aircraft carrier.

The heroic stamina of the Maltese citizens was recognized by King George by the presentation to all the population of the George Cross. The author, who spent two years as information officer, describes the life during the continuous attacks and shows the hardships that were undergone.

Army Talk, by Elbridge Colby; Princeton University Press, Princeton, N. J., 1943; 234 pages, $2.00.

Through the years the Army has developed a vocabulary of its own. Dictionary definitions lag behind usage. Therefore a book in which a scholarly and informed study of specialized terms used by military men will be most useful. This book not only defines the words most frequently encountered but also includes the abbreviations and slang that are so necessary to an understanding of a soldier's talk.

The Air Forces have not only taken over the Army vocabulary but have enriched it with hundreds of new words. Many of these are included in the scope of the book, which will be useful not only to the military man but to the layman who has to be familiar with many words and phrases now current.

War Wings, by Rutherford G. Montgomery; David McKay Company, Philadelphia, 1943; 224 pages, $2.00.

A narrative of continuous air fighting from cover to cover, this book relates the experiences of three Royal Air Force pilots (one an American) over England and the continent, in Africa, and in the Far East. Illustrated by Clayton Knight, the stories are told in airmen's language with all the details that make it a thrilling adventure tale.

Civilian Defense, by C. E. Walton; Bruce Humphries, Inc., Boston, 1943; 166 pages, $1.50.

A compact handbook for the use of air-raid wardens. It gives the essential information needed for protection against bombing and gas with instructions as to procedure in rendering emergency first aid after attacks.

The Army in Review, by Curtis L. Erickson; E. P. Dutton & Company, Inc., New York, 1943; 218 pages, $2.50.

Two boys were asked by their teacher to write a term report on the U.S. Army. Instead of taking their information from books and pamphlets, they asked the Commanding Officer of an area where all the various activities of the Army were centered, and he arranged for them to take a personally conducted tour of the camps.

Their visit to an airfield gives a sketch of the normal work done by the Air Forces. The remainder of the book gives the impressions the boys received of other branches of the Army.

The Framework of Battle, by John G. Burr; J. B. Lippincott Company, Philadelphia, 1943; 254 pages, $3.00.

This guide for the layman to the technique of warfare is an epitome of the studies by officers at General Staff schools. It explains the grand strategy used in many of the great campaigns of history, as well as those of the present war. It deals almost entirely with ground warfare and does not emphasize the role vertical warfare is playing today. To the author the principles of the science of war are immutable and differences of the tools of armies do not, and never will, change them.

A Yankee Flier in North Africa, by Al Avery; Grosset & Dunlap, New York, 1943; 214 pages, $0.60.

Though fiction, the story of three members of Red Flight in North Africa reads like an account of actual fighting.

Bill O'Malley's use of a hoodooed P-40 and his success in combat, with his two pilot friends, make a yarn that is a thriller from cover to cover.

He's in the Marine Corps Now, by Josef Israels II; Robert M. McBride & Company, New York, 1943; 191 pages, $2.50.

Included in a graphic and popular description of the Marine Corps is an account of the origin and growth of the flying Marines. Since Lieutenant Cunningham became interested in aviation in 1912, the Marine Corps' activities with airplanes have steadily grown until now its squadrons are some of the most famous in the Navy. Pilots of the Marine Corps such as Major Lofton R. Henderson, Major John Smith, Lt. Marion Carl, and many other aces have added fame to the corps of fighting men who have always been in the forefront of all wars.

Israels' book will bring the duties and the methods of the Marine Corps clearly to the reader and lead to a better understanding of its differentiation from the Navy.

Financial Position of the Aircraft Industry, by Lynn L. Bollinger and Tom Lilley; Harvard University Graduate School of Business Administration, Boston, 1943; 30 pages, $1.50.

A report based on the financial statements of eleven major air-frame manufacturing companies at the end of 1942 stresses the difficult financial problems to be expected in the event of conversion to peacetime operations within the next few years. It is noted that the weak working-capital position of the industry apparently will not affect operations during the war, because the Government is supplying substantial cash advances and large inventories. Since these problems are the direct result of the war, major corrective measures will have to be initiated by the Government.

It is shown that three important risks are involved in the limited working-capital position: (1) Present corporate resources may prove inadequate to absorb losses arising from contract cancellation and inventory liquidation; (2) subsequent costs of contraction and conversion may consume part or all of available funds; (3) remaining capital, added to what can be raised, may be insufficient to maintain peacetime employment and production. The expenses of retooling and returning to civilian output and the effects of renegotiation and taxes are studied, and the conclusion is reached that conventional methods of measuring net profits do not accurately reflect the true earning ability of the industry. Until all war expenses are taken into account, including liquidation losses and conversion costs, it will be impossible to determine true profit.

American Warplanes, by Elizabeth Mallett Conger; Henry Holt and Company, New York, 1943; 161 pages, $2.00.

Boys and girls have taken such an interest in the development of airplanes that a book primarily written for those under 12 years of age will find a wide reception. In clear, simple language, fighters, bombers, reconnaisance planes, gliders, and other types of airplanes are described. There are also chapters on parachutes, carriers, and the Link trainer.

Physikalische Hydrodynamik, by V. Bjerknes, J. Bjerknes, H. Solberg, and T. Bergeron; Edwards Brothers, Inc., Ann Arbor, Mich., 1943; 797 pages, $18.

The purpose of this book is to present the principles and practical applications of physical hydrodynamics. The authors offer the hypothesis that if all space beyond the atmosphere of the earth is pervaded by ether, which conducts light and distant effects, it must have at least one property in common with fluid media—namely, that it may be penetrated by bodies in motion. Accordingly hydrodynamics, the science of the motion of fluid media, seems to be destined to occupy a central position among the physical sciences. Although its development for the time being has been kept within narrow limits, almost the entire literature of classic hydrodynamics has assumed that the fluid medium is either homogeneous or noncompressible. In case compressibility is considered, it is assumed that density, in reference to time and space, depends only on pressure.

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These assumptions are shown to define the limits of classic hydrodynamics. Because of the characteristics of the definition, the authors hold that the fluid of classic hydrodynamics cannot be used as an operating substance in thermodynamic machines; consequently, there is no connecting link between hydrodynamics and thermodynamics, and so there can be none between hydrodynamics and the other physical sciences. Classic hydrodynamics is pure hydrodynamics. Any reference to the reciprocal effect of motion due to heat supply and heat discharge by conduction and radiation, and so to the important hydrodynamic-geophysical or hydrodynamic-cosmic problems, leads beyond the limits of classic hydrodynamics. These problems are assigned to the more general science of "physical hydrodynamics," where the fluid has full physical reality, especially since temperature appears in the equation of state as a variable in addition to pressure and density, or where at least space is reserved for it in case it is not especially introduced.

The book has been reproduced by photo-lithoprint and is published and distributed by authority of the Alien Property Custodian.

Trade Area Airline Service; Braniff Airways, Inc., Dallas, Tex., 1943; 59 pages.

Braniff Airways has published its reply to the Civil Aeronautics Board's inquiry for information pertinent to the investigation of local feeder and pickup air service. The 59-page brochure gives the company's views on the need for feeder air service, an explanation of trade area air-line service, delineation of trade area, and operation of trade area air-line service. It also contains 24 maps and charts illustrating its thesis.

Among the major conclusions are the four following statements: (1) The time is now ripe for extension of air transportation benefits to cover the towns, small communities, and rural areas not now enjoying the benefits of commercial aviation. (2) The type of service can be provided with modern twin-engined aircraft at a cost not to exceed the cost per mile of rural service. (Rural mail service now costs $3.13 per capita. Air service can be extended at a cost of 36 to 47 cents per capita.) (3) The principal need for the communities to be served is direct connection with their trade centers. (4) The extension of trade area air-line service must be done on a basis that will not result in uneconomical and unintended duplication of and competition with existing air services.

The National Fire Codes for Flammable Liquids, Gases, Chemicals and Explosives, compiled by Robert S. Moulton; National Fire Protection Association, Boston, 1943; 502 pages.

A compilation of comprehensive standards on various phases of fire prevention and fire protection issued in the form of codes, advisory standards, recommended good practice requirements,

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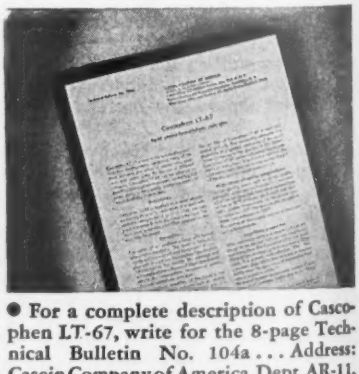

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and suggested ordinances. This volume supersedes the *National Fire Codes for Flammable Liquids and Gases*, Edition of 1938. The material is divided into nine parts: the first, dealing with flammable liquid storage and handling; the second, with oil and gasoline burning equipment; and the third, with liquified petroleum gases. Part IV is concerned with the utilization of flammable liquids; Part V, with gases; and Part VI, with refrigeration and fumigation. In Part VII explosives and nitrocellulose materials are covered; Part VIII contains tables of properties of hazardous chemicals and flammable liquids; and the final portion of the book is devoted to discussion of flash-point tests.

The Outlook for Domestic Air Transport, by Ernest W. Williams, Jr.; National Planning Association, Washington, D.C., 1943; 30 pages, $0.25.

Adapted from a study made by the author when he was associated with the National Resources Planning Board, this report indicates the trends of domestic air transport and what they portend for the postwar period. In addition to examining the basic characteristics of air transport, effects of war, and recent technical trends and prospects, the author discusses traffic potentialities, problems and obstacles to be overcome, the place of air transport in the political and international scene, and the role of government. Several recommendations are made with regard to promoting air transportation in the future.

How to Maintain Electric Equipment in Industry; General Electric Company, Schenectady, N.Y., 1943; 372 pages, $1.75.

The maintenance of General Electric equipment used in industry is given. Preventive-maintenance charts and trouble-shooting charts on nearly all types of apparatus are included in the book, and there are over 500 illustrations. Photographs and diagrams give suggestions on maintenance procedure.

Methoden Und Probleme der Dynamischen Meteorologie (Methods and Problems of Dynamic Meteorology), by H. Ertel; Edwards Brothers, Inc., Ann Arbor, Mich., 1943; 122 pages, $4.50.

An outline of selected problems in dynamic meteorology and of methods that have been applied up to the present in their solution. No claim of completeness is made for this book by comparison with the more extensive textbooks on dynamic meteorology, yet it offers many new aspects to the profession. Among its contents may be mentioned: reference to the representation of the Lagrange equations of hydrodynamics; a new formula for the calculation of the Rossby function of advection; derivation of the equilibrium condition of the tropopause and of the Palmén tropopause funnel; and the theory of the relaxation time of gradient wind deviations.

The current edition has been reproduced in the German language by photolithoprint and is published in the United States by the authority of the Alien Property Custodian.

The Star Finder, by Henry M. Neely; Smith & Durrell, Inc., New York, 1943; 58 pages.

A simple and elementary preparation for studies of astronomy and navigation. This primer instructs the novice on the stars and how to use star charts. Six complete star maps, with directions for "on location" use, are included.

The Inside Story of the Flying Fortress, by Jim Ray; Garden City Publishing Company, Garden City, N.Y., 1943; 30 pages.

A series of detailed drawings is featured in this children's story of the history, design, and operation of the Boeing B-17. The illustrations help to explain the construction of the Fortress's fuselage, wings and tail, engines, and landing gear. With emphasis upon the teamwork of the entire bomber crew, the roles played by the pilot and copilot, bombardier and navigator, aerial engineer and gunner, radio operator, and waist gunner are dramatized. Details of how Fortresses are camouflaged and an account of the bomber's evolution are included.

A Start in Meteorology, by Armand N. Spitz; The Norman W. Henley Publishing Company, New York, 1943; 97 pages, $1.50.

The second and expanded edition of an introduction to meteorology for students and laymen. The basic principles of meteorology are set forth in easily understood language.

Soldiers on Parade, by Capt. Benjamin E. Grant; Miami Offset Company, Miami, Fla., 1943; 48 pages, $0.35.

A collection of light poems about Army men and Army life, with the subject matter selected from experience with the Army Air Forces at Miami Beach. Part of the receipts from the sale of this book will be turned over to the Army Air Forces Aid Society.

Semper Fidelis, The United States Marines in Action, by Keith Ayling; Houghton Mifflin Company, Boston, 1943; 194 pages, $2.00.

This book on the United States Marine Corps not only relates the story of the Marines in action on Guadalcanal, Wake, Midway, and other Pacific fronts but also describes the tradition of the Marines. It tells, too, of the opportunities offered to young men who join this branch of the Service. A special chapter is devoted to the combat correspondents attached to the Marine Corps.

Patent Law, by Chester H. Biesterfeld; John Wiley & Sons, Inc., New York, 1943; 225 pages, $2.75.

Intended for chemists, engineers, and students, this is a compilation of a series of lectures given at the University of Delaware on the substantive patent law. It is a simple treatment of the fundamental principles underlying the law and is offered as a basis of knowledge for those who are confronted with questions of patent law and practice in their daily research and technical work. The study is supported by citations and quotations taken from court decisions.

Nancy Naylor Flies South, by Elisabeth Lansing; Thomas Y. Crowell Company, New York, 1943; 241 pages, $2.00.

Third in a series of girls' books about an air stewardess and her adventures in South America.

Weight Handbook Volume II, Society of Aeronautical Weight Engineers, Inc., June, 1942; $4.00.

This second volume of the Society of Aeronautical Weight Engineers Weight Handbook contains the weights of all purchased aircraft equipment and accessory items in current use. It is stated that over 300 accessory and equipment companies were contacted in securing the data. The information listed is intended for general use and is not to be construed as having been officially approved by the Government of the United States. The publishers emphasize that all weight values finally used in connection with military aircraft must be approved by the procuring agency of the Government.

The Goodyear Research Laboratory, by David Dietz; The Goodyear Tire & Rubber Company, Akron, O., 1943; 57 pages.

In connection with the dedication of the Goodyear Research Laboratory, this small book contains the writer's impression of the past, present, and future of The Goodyear Tire & Rubber Company. The first chapter gives a review of the conversion of the company's facilities from the manufacture of a wide variety of peacetime goods to the manufacture of a large number of products for the nation's war effort.

The second chapter recites the story of rubber and explains the processes of developing and producing synthetic rubber.

Chapter three is devoted to the history of the Goodyear company with particular refer nce to the contributions of its founder, Frank A. Seiberling, and his successor, Paul W. Litchfield. In this chapter there is related the development of Goodyear lighter-than-air craft, as well as the building of complete airplanes.

Chapter four covers the research achievements of the Goodyear organization, including the special products that have been developed in the company's laboratories.

The fifth chapter contains a detailed description of the new Research Laboratory and its complete facilities for carrying on the research work of the organization.

How the Army Fights, by Lowell M. Limpus; D. Appleton-Century Company, Inc., New York, 1943; 388 pages, $3.00.

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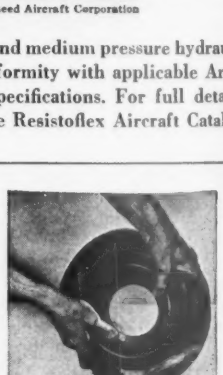

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RESISTOFLEX CORPORATION, BELLEVILLE, NEW JERSEY

In this interpretation of techniques of modern warfare, the latest equipment of the U.S. Army is described and various strategies employed in combat are explained. The subject matter is divided into six parts: The first outlines America's military problem; the second discusses the tools with which she fights; the third depicts the applications of modern weapons; the fourth examines methods of modern warfare; the fifth is devoted to the supply services; and the sixth deals with portents of the war and its effects.

XC Navigation, by C. Mardoni Hines; C. Mardoni Hines, Elburn, Ill., 1943; 64 pages, $2.50.

The information students will require to pass examinations in private, secondary, cross-country, and commercial navigation is given in this book. It is written from actual ground-school experience and contains material used by the author in instructing Army and Navy cadets, as well as private and commercial students. The scope of instruction is from simple piloting to problems involving alternate airports and interception.

Physical Constants of the Principal Hydrocarbons, Compiled by M. P. Doss, Technical and Research Division of The Texas Company, New York, 1943; 215 pages.

The latest information on the physical constants of the hydrocarbons is given in tabular form. This is the fourth edition of the book.

The tables have been prepared and revised in the belief that the information would be of assistance to laboratory workers by making it available in convenient form. Although the tabulation does not purport to be complete, it is stated that a considerable proportion of the data given is not cited in recognized reference books or, at most, literature references are given but not the desired values themselves. It is believed by the publishers that most of the aliphatic hydrocarbons so far isolated or synthesized are included.

Trail Blazers to Radionics and Reference Guide to Ultra High Frequencies, by E. Kelsey; Zenith Radio Corporation, Chicago, 1943; 56 pages.

The first part of this book contains brief bibliographic sketches of scientists who have contributed directly or basically to the development of radionics in all its branches.

The reference guide to ultra-high frequencies contains lists of books on the subject, articles that have appeared in engineering publications, and a frequency-modulation bibliography.

Tungsten, by K. C. Li and Chung Yu Wang; Reinhold Publishing Corporation, New York, 1943; 325 pages, $7.00.

One of the American Chemical Society Series of Scientific and Technologic Monographs offers a comprehensive study of tungsten for industrial use and as a strategic war metal. It covers the history, geology, ore-dressing, metallurgy, chemistry, analysis, industrial applications, and economics of tungsten.

The first chapters tell of the discovery of the ore and the geologic formations in which it occurs, with information on the countries and localities where deposits are found. Following chapters tell how the ore is treated and prepared for use. The metal is analyzed from the metallurgic and chemical standpoints, and substitutes for tungsten are discussed in connection with various industrial applications. The closing chapter covers the economics of tungsten, including figures on production prices, markets, and other industrial factors. Appendices offer further information on commercial handling of the metal.

Fundamental Shop Training for Those Preparing for War Service, by John T. Shuman, Capt. Bailey Wright and James Ritchey; American Technical Society, Chicago, 1943; 355 pages.

A basic course in fundamental shop skills and techniques is offered. Information necessary to the operational skills that are essential to more than 20 Army occupations is given. The course is designed to develop manipulative skills and to impart a knowledge of the qualities and characteristics of materials and of construction processes and procedures. The "how-to-do-it" method of presentation is followed.

The text itself is devoted mainly to principles and methods. An accompanying workbook contains detailed instructions based on the six-step plan of presentation. A series of elementary projects to be worked out by the student is contained in this workbook.

Solution of Equations, by Wayne A. McGowan; Aero Publishers, Los Angeles, 1943; 302 pages, $3.00.

Because many problems encountered in industry require a knowledge of several of the mathematical subjects, this text has been written to include, within a single volume, the fundamental principles of algebra, geometry, trigonometry, logarithms, and the analytical geometry of straight lines. The author is an aeronautical engineer.

This second edition contains an appendix explaining the use of the slide rule and includes tables of trigonometric functions and the logarithms of numbers. Problems and answers to the problems are also included.

Airplane Structures, Volumes I and II, by Alfred S. Niles and Joseph S. Newell; John Wiley & Sons, Inc., New York, 1943; Vol. I, 439 pages, $4.50; Vol. II, 454 pages, $4.50.

Information on the more commonly used airplane materials and methods of stress analysis is presented in these two volumes, which are offered in revised form. The principal changes in Volume I are the clarification of some articles and the rewriting of others to make them consistent with the second volume.

In Volume II, six new chapters have been added which are devoted primarily to problems connected with the types of metal and plywood construction which are now being used. They cover the analysis of beams having incomplete tension-field webs; the computation of shear flow in thin shells such as monocoque wings and fuselages; the determination of stresses in curved beams and rings; basic methods for dealing with the stability of beams and trusses; the application of the calculus of variations to the torsion-bending stability problem in open-section columns; and allowable stress data and characteristics of some of the newer materials.

Boundary-Layer Problems in the Atmosphere and Ocean; Annals of The New York Academy of Sciences, Volume XLIV, Art. 1, 104 pages, $1.15.

This series of papers is the result of a conference on Boundary-Layer Problems in the Atmosphere and Ocean held by the Section of Oceanography and Meteorology of The New York Academy of Sciences, March 6 and 7, 1942.

The titles of the papers are as follows: Introduction to the Conference and Some Applications of Boundary-Layer Theory to the Physical Geography of the Middle West, by C.-G. Rossby; The Influence of Stability on Evaporation, by Benjamin Holzman; Sources of Atmospheric Heat and Moisture Over the North Pacific and North Atlantic Oceans, by Woodrow C. Jacobs; Turbulence and the Transport of Sand and Silt by Wind, by A. A. Kalinske; Boundary-Layer Problems Involved in Snow Melt, by Phillip Light; The Effect of a Gradual Wind Change on the Stability of Waves, by B. Haurwitz; On the Ratio between Heat Conduction from the Sea Surface and Heat Used for Evaporation, by H. U. Sverdrup; Generalization for Cylinders of Prandtl's Linear Assumption for Mixing Length, by R. B. Montgomery.

Pilote de Guerre, by Antoine de Saint Exupéry; Éditions de la Maison Française, Inc., New York, 1943; 281 pages.

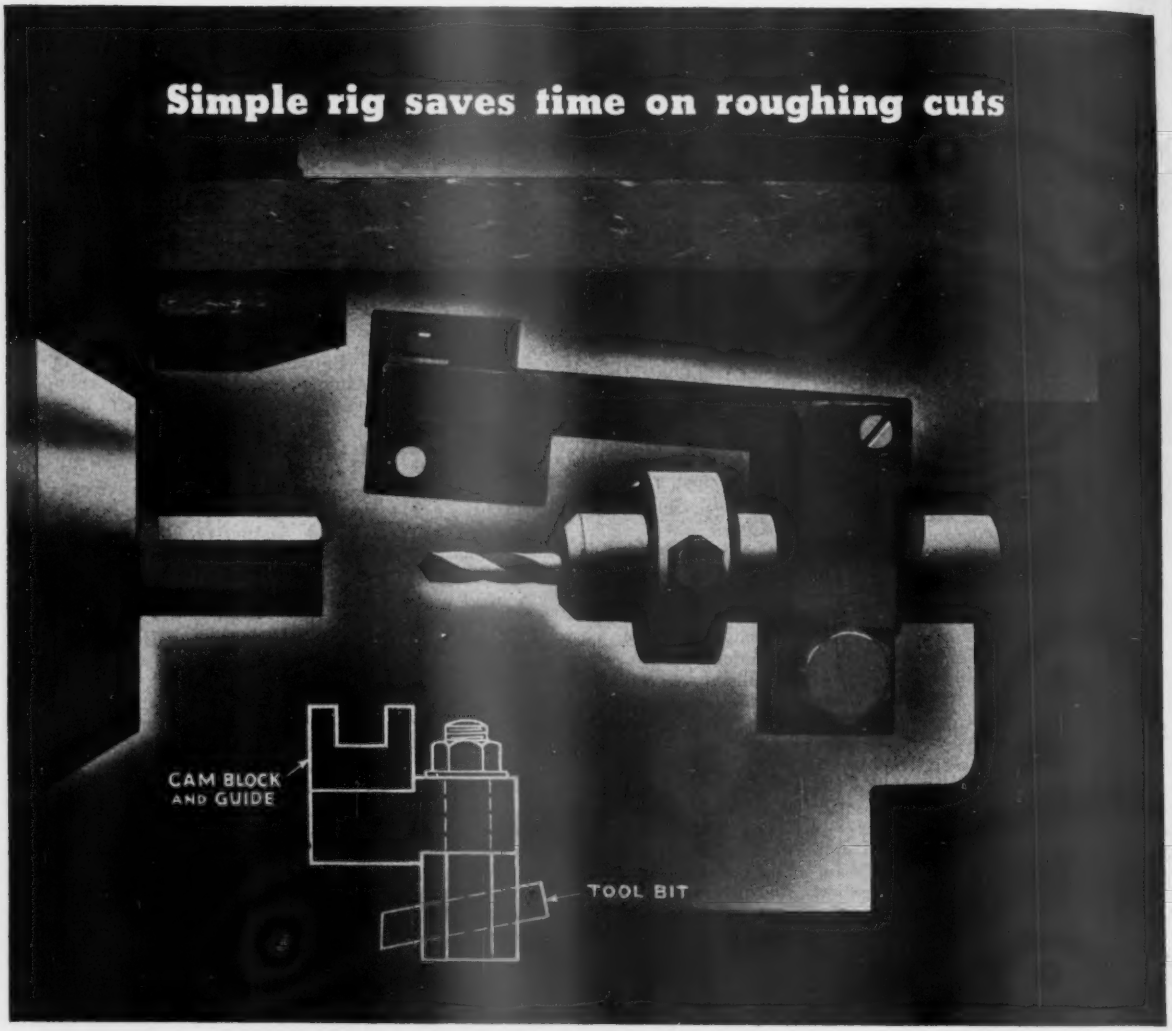
This edition in French of the book that appeared in English under the title "Flight to Arras" was prepared to enable young American people who wish to learn French to get an idea of the beauties of the French language, since few French writers approach the author in his vivid poetic prose.

Annotations, questionnaires, and a dictionary have been added to complete the book.

Attitude, by Jerome Lederer; Airlines War Training Institute, Washington, D.C., 23 pages, $0.15.

A booklet containing suggestions and advice for aircraft flight crews. Among the subjects covered are the correct attitude toward superiors and subordinates; crew behavior and duties en route; the responsibility and authority of the captain; performance in air emergency; and tact, attitude, and behavior during foreign travel.

Simple rig saves time on roughing cuts



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Roughing tools conventionally mounted on turret lathes or hand screw machines have a tough time cutting hex bar stock. Intermittent cutting, accompanied by successive severe shocks make frequent resharpening necessary. This means equally frequent machine shutdowns.

The problem of eliminating the lost time on such jobs has been solved in a New England plant by an ingenious rig applied to some old turret lathes.

The rig consists essentially of two bars. One, carrying the roughing tool, is pivoted to the turret. The other, having a very simple adjustable cam on its lower side, is fastened between the top of the turret and a sliding support on the headstock.

As the turret advances the roughing tool, the cam feeds it downward, then guides it horizontally and supports it transversely while the roughing cut is made. A drill or other inside tool may be fed in to work simultaneously.

When the roughing cut is finished, the tool is backed off, and the finishing tool fed in on the cross slide. When the roughing tool needs resharpening, it is simply a matter of a few minutes to take it out of the holder and put a sharp tool in. Shutting down is unnecessary. There is less need for expert grinding and resetting.

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Reference Data for Radio Engineers; Federal Telephone and Radio Corporation, New York, 1943; 200 pages.

A compilation of radio reference data presented as an aid to radio research, development, production, and operation. It is intended to meet the requirements of both the engineer and the practical technician. In order to fill the gap that has extended between the handbook and the standard engineering textbook, more fundamental data has been included than is usually found in a radio handbook.

Pogo's Sky Ride; A Story of Airplanes, by Jo and Ernest Norling; Henry Holt and Company, New York, 1943; 45 pages, $1.25.

One of a series of books for children. It is a story about airplanes and how they are built.

I Want to Fly, by Anita Brenner; William R. Scott Inc., North Bennington, Vt., 1943; 33 pages, $1.50.

A "picture-book" for young children. The text is secondary to the multicolored line drawings.

Encyclopedia of Substitutes and Synthetics, edited by Morris D. Schoengold; Philosophical Library, New York, 1943; 382 pages, $10.

An encyclopedia of products that have been recently developed in order to replace critical materials that have become difficult or impossible to obtain because of present world conditions.

The book covers substitutes of interest to all branches of industry. It also includes explanations of plastics and other synthetics that for years have been replacing many of the commonly known applications of metal.

Navigational Trigonometry, by Paul R. Rider, and Charles A. Hutchinson; The Macmillan Company, New York, 1943; 232 pages, $2.00.

Prepared to meet the increased interest in surface and aerial navigation, this book is a revision and expansion of part of Rider's *Plane and Spherical Trigonometry.* It is intended to provide the reader with a mathematical understanding of the basic problem of navigation—that is, the solution of a spherical triangle.

Audels Aircraft Worker, by W. H. Alderman; Theo. Audel & Company, New York, 1943; 228 pages, $1.00.

In writing this book the author's object has been to give practical information in concise form on subjects of value to the worker entering an aircraft factory. In order to supply the maximum information within the space allotted, numerous illustrations are given showing modern methods of aircraft assembly and fabrication.

Because of the importance of mathematics in the field of aircraft construction, a section is provided giving several examples in the calculation of problems of a type encountered in practical work.

The book is divided into two main parts: one devoted to aircraft assembly; the other, to tables and data.

(*Continued from page 54*)

Maximum Ton-Hours per Day

Fig. 10 shows that to develop the optimum value for ton-hours per day per ship flights of less than 6 hours in length are going to have to be made. Crew efficiency drops off rapidly for flights of this length. Even if the upper of the two curves for crew efficiency is used, the flights should be of 8 hours' duration. It is doubtful if the possibility of the use of this upper curve for the crew should even be considered. The elements that would make the use of this curve practical are absent in a type of operation that calls for the development of maximum cargo space and frequent stops. It therefore seems most practical to change crews as often as is necessary. This will make possible a reduction in the size and weight of the crew, the crews' baggage, and the space occupied by the crew. Frequent stops will make possible frequent meals ashore with a consequent reduction in the amount of galley equipment that need be carried. All this adds up to a raising of the curve above the maximum point shown on the graph.

Bottleneck Flights

There is still one important exception to the above conclusions. A choice of the length of the flights is not always possible. Almost any route in long-range operations will contain one or more long flights that are irreducible in length. These are usually ocean crossings. These flights introduce a bottleneck in the route. The average length of six such bottleneck flights in current use is 13.2 hours. Consider that the load carried on a flight of this length will not be added to at any other point along the route and a curve of ton-hours per day, represented by the dotted curve across the lower part of Fig. 10, is obtained. There are four ways of meeting this problem. It will be noted that the bottleneck flight is just about twice the length of the flight that produces maximum ton-hours per day. It is therefore possible to start the flight with a full ship making flights of $6^1/_2$ hours. When the bottleneck is reached half the load is dropped. The flight is made and then the ship returns for the off-loaded half of the cargo. On the other side of the bottleneck it continues once more with a full load, making flights of $6^1/_2$ hours.

A second method is to load the ship at the point of origin with a transit load equal to the maximum that can be carried across the bottleneck. The remainder of the space made available by the shorter flights is filled with local load.

A third method restricts the use of ships of this capacity to just the bottleneck section of the route. Smaller ships feed them from both ends. In the fourth system the ship loads at the port of origin with just the load that is transiting the bottleneck. All of its flights will be of the same length—in this case 13.2 hours.

The first two methods call for a frequent change of crew, the third method may be used with a continuous crew, and the fourth method should use a continuous crew provided the upper crew curve can be achieved.

Some comments are in order pertinent to the use of the second method outlined above—the one in which residual space was taken up with local traffic. It sometimes happens that this type of goods would not normally travel by air, but, because a transit ship can be flagged down and space made available, it is put aboard to swell the load. This is good commercial practice. But it should be noted that unless the addition of the local loads can peak the curve above the value obtained at 13.2 hours the ship had better go through the port without stopping. In plotting this point on the curve full value may not be ascribed to this type of local goods. It must be given a fractional value based upon its value relative to that of the transit load. For example, if a 5-hour flight is to be made, it can be seen from the curves that the pound-for-pound value of the local goods used to top off the transit load must be in excess of one-quarter of the value of this transit load. Otherwise the penalty in lowered ton-hours per day is too heavy against the transit load and it would be more productive to pass up the station.

Few problems are so simple that a single patent nostrum will solve them. The actual operations discussed have been no exception. Almost every method of attack discussed has been applied at one point or another.

Realization of the program discussed in this paper should double the productivity of our fleet of long-range aircraft. Using the technique outline and with a careful attention to detail, the work of 500 ships can be done with 250. A long stride in that direction has already been made.

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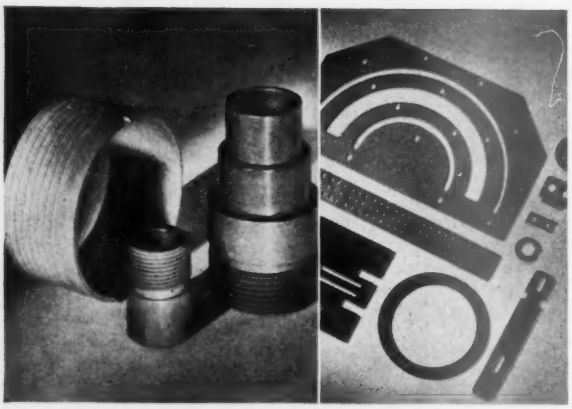

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Supplementary to the lists published in June, September, and October, 1943, issues of the Aeronautical Engineering Review

Aeronautical companies and other organizations may borrow copies of these translations through the facilities of The Paul Kollsman Library upon application by the company librarian. Because of the importance of this material, the regular library loan period has been extended to two weeks, in order that these translations may be utilized to their full advantage. Requests should be made by number, author, and title on the regular Library book request cards. Because of the many requests for these translations, no more than five copies may be borrowed at one time by one organization.

The translations have been reproduced from typewritten copy and the number of pages in each is indicated at the end of each reference. Bibliographic information has been taken directly from the translations. Photostatic copies are also available at the usual library rates.

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805 Nemchinov, V. *Choice of optimum altitude and regime of flight.* Grazhdanskaia aviatsiia, U.S.S.R., v. 8, no. 6, June, 1938, p. 15–18. 7 p.

856 Isermann, R., and Beck, E. *Take-off by running down a steep slope.* Jahrbuch der deutschen luftfahrtforschung, v. 1, 1938, p. 306–312. 27 p.

Seaplanes and Flying Boats

433 *The performance of modern long range seaplanes.* Flugsport, v. 29, no. 3, February 3, 1927, p. 79–83. 7 p.

710 Lorenzelli, E. *Graphical investigation of the coefficients of resistance and of hydrodynamic moment of a hydroplane and the determination of the best wing setting.* L'Aerotecnica, v. 18, no. 1, January, 1938, p. 64–77. 26 p.

Military Aeronautics

738 Ernst Heinkel flugzeugwerke. *The Heinkel He 112 single-seater fighter.* Descriptive pamphlet. 1938. 37 p.

802 Kurenskii, M. M. *Movement of a projectile in a medium of variable density.* Mémorial de l'artillerie française, v. 16, no. 3, 1937, p. 753–766. 23 p.

808 *Electro-hydraulic device for pointing aircraft guns (Oerlikon).* Luftwehr, v. 5, no. 5, May, 1938, p. 203–204. 5 p.

Power Plants

575 Zolotarev, N. S. *Stress analysis of engine elements.* Tekhnika vozdushnogo flota, U.S.S.R., v. 11, no. 4, April, 1937, p. 48–60. 20 p.

793 Gothert, B. *The air resistance of aircraft radiators under conditions of heat transfer (comparison of theory and experiment).* Luftfahrtforschung, v. 15, no. 9, September 10, 1938, p. 427–444. 68 p.

819 Leist, K. *Problems connected with the construction of exhaust gas turbines.* Luftfahrtforschung, v. 15, no. 10-11, October 10, 1938, p. 481–494. 48 p.

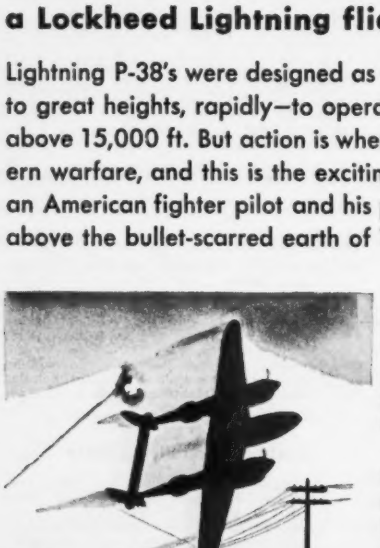
(*Continued on page 187*)

CAPTAIN HOELLE'S SOMERSAULT

Flipped on its back by a telephone pole a Lockheed Lightning flies home

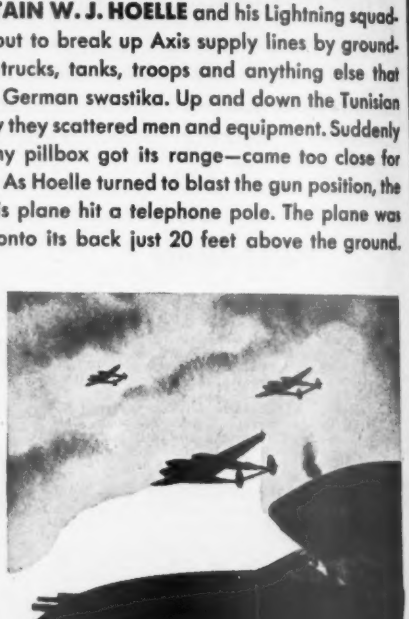
Lightning P-38's were designed as interceptors—to climb to great heights, rapidly—to operate at peak efficiency above 15,000 ft. But action is where you find it in modern warfare, and this is the exciting, true experience of an American fighter pilot and his plane just twenty feet above the bullet-scarred earth of Tunisia.

1. CAPTAIN W. J. HOELLE and his Lightning squadron set out to break up Axis supply lines by ground-strafing trucks, tanks, troops and anything else that bore the German swastika. Up and down the Tunisian roadway they scattered men and equipment. Suddenly an enemy pillbox got its range—came too close for comfort. As Hoelle turned to blast the gun position, the tail of his plane hit a telephone pole. The plane was flipped onto its back just 20 feet above the ground.

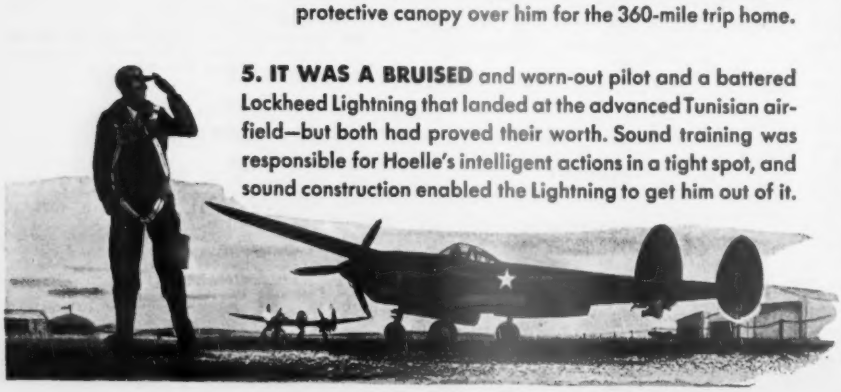


2. COOLLY, INSTINCTIVELY, Hoelle kicked full top rudder and full left aileron. The Lightning bounced crazily along through space, gradually working itself into a right bank position.

3. TOO LOW TO JUMP, too low to maneuver, impossible to land, it looked like "curtains" for Hoelle. Then he thought of lowering the wing flaps usually used for controlled landings. This gave the Lightning just the lift that was needed to pick up altitude and start home.



4. FLYING SPEED had been greatly reduced, and Hoelle's Lightning would have been easy bait for German fighters if his squadron mates had not formed a protective canopy over him for the 360-mile trip home.



5. IT WAS A BRUISED and worn-out pilot and a battered Lockheed Lightning that landed at the advanced Tunisian airfield—but both had proved their worth. Sound training was responsible for Hoelle's intelligent actions in a tight spot, and sound construction enabled the Lightning to get him out of it.

This is another in a series of stories about Lockheed and Vega and their accomplishments. Watch the pages of this magazine for another true aviation adventure.

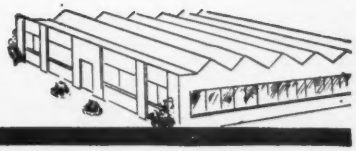
LOOK TO

Lockheed

FOR LEADERSHIP

Lockheed Aircraft Corporation, Vega Aircraft Corporation, Burbank, Calif.

House Organs and Catalogues



Oil Performance

Piston-Ring Scuffing as a Criterion of Oil Performance. George H. Keller. In order to determine how some of the improvements in aircraft-engine lubricating oil could be used to advantage in engines operated under borderline conditions and to show that under such conditions oils meeting current specifications do have appreciably different lubricating properties, tests were conducted with a full-scale, single-cylinder, air-cooled aircraft engine in which most of the important variables could be evaluated and controlled.

The conditions under which the test was carried out are described. The relative merits of the oils under test were determined by the conditions of the rings and piston following the test, the oil consumption during the test, and blowby during the test. A new-oil and used-oil analysis of the several oils tested is presented. The mechanical condition of the piston and rings after the test is also given.

It is stated that the data clearly illustrate that it is possible, by utilizing modern developments in lubricating oils, to supply adequate lubrication to the piston and cylinder wall of the high-output, air-cooled engine under severe operating conditions. It is also found to be evident that laboratory inspection is not a sound basis for determination of the lubricating qualities of oils.

In the final analysis the only satisfactory evidence for comparing the lubricating qualities of different oils is the mechanical condition of the engine parts following testing under standardized conditions. The piston rings offer the most difficult lubrication problem in the engine, and it is therefore consistent that this condition be used as the criterion for rating lubricating oils. *The Intava World*, July.

Snap Switches

Lightweight precision snap switches, manufactured for a wide range of applications, are described in a 10-page catalogue. Following an explanation of the principles on which these switches operate, details on the various types of switches manufactured are given. Photographs, sectional drawings, and tables of dimensions are included. *Acro Electric Company*, Cleveland, O.

Acid-Type Cleaning Material Manual

Data on acid-detergent techniques, designed to remove many types of deposits from ferrous and nonferrous metal parts during fabrication, are given in a new, 12-page instruction manual.

The manual briefly reviews the application of a recently developed acid-type material to a number of varied metal-cleaning operators. It describes how the acid-detergent material, known as Oakite Compound No. 84 and usually applied after thorough alkaline degreasing, solves cleaning and related problems on such varied production operations as: removing oxide films and stains, as well as light rust, from steel; detarnishing and brightening brass and copper; safely ridding aluminum surfaces of oxide and heat-treat films; preparing aluminum for anodizing; cleaning before application of Alrok Finishes; stripping anodizing from aluminum work racks and rejects; and tumbling small steel parts. Information is given on cleaning with this material factory, foundry, and mill skylights and windows where rust, carbon, soot, shop dirt, and other soils are encountered. *Oakite Products, Inc.*, New York.

Synthetic Rubber Manufacture

The story of development and manufacture of synthetic rubber is told in a 44-page booklet titled *Towers of Triumph.* Answers to common questions on synthetic rubber are given. Operations in the manufacture of synthetic rubber from coal and oil by the polymerization of styrene and butadiene are portrayed diagrammatically.

Photographs show synthetic rubber operations as seen in a trip through the plant of the Copolymer Corporation where Buna-S type synthetic rubber is manufactured. *Dayton Rubber Manufacturing Company*, Dayton, O.

Equipment Catalogue

Handbook No. 143 is a complete catalogue of the products made by the Ideal Commutator Dresser Company. There are sections on maintenance equipment, coil winding equipment, wire insulation strippers, portable industrial cleaners, brazing and soldering tools, and safety tools and equipment. Other sections are devoted to flashlight storage batteries, fuse devices and tools, wiring devices and tools, electric marking tools, machine tool accessories, and variable speed transmissions. In addition, several tables of pertinent miscellaneous data are included, as well as information on the care of commutators, different types of commutator troubles and remedies, the operation of direct current generators, and definitions of electrical terms. *Ideal Commutator Dresser Company*, Sycamore, Ill.

Specifications for Plywood

Government specifications for plywood and adhesives are covered in an 18-page bulletin (*Bulletin No. 5*, September, 1943). It first describes four basic specifications that are widely recognized and from which most of the other departmental specifications are developed with more or less modification to meet special requirements. Departmental specifications then are given.

Information is furnished on adhesive requirements and test procedures. The recommended adhesive for each requirement is given. *The Rohm & Haas Company*, Philadelphia, Pa.

Tubing

The Aircraft Tubing Manual. A 32-page manual on aircraft tubing has been compiled with the aid of technical data from Douglas Aircraft Company. In the first part of the booklet information is given on the applications and types of seal-caps and seal-plugs for protecting and sealing tubing, threaded fittings, and hydraulic units. The second part describes in detail the fabrication, handling, installation, testing, and protection of aircraft tubing. *Tubing Seal-Cap, Inc.*, Los Angeles, Calif.

Chart for Riveting Operations

A wall chart containing information on Cherry blind riveting operations has just been published for aircraft plants, schools, field service depots, engineering departments, etc. A special feature of the chart is a scale reproduction of both countersunk and brazier head rivets showing the proper rivet to be used in any thickness of material from 0.030 to 0.391 in.

Three columns of data on rivets offer a guide to rivet sizes for three types of installations. Two columns deal with flush riveting: One of these is for double dimpled construction and the other deals with the combination of machine countersunk or dimpled top sheet and machine countersunk bottom sheet. The third column shows proper sizes for brazier head riveting in various thicknesses of material.

Photographic illustrations and cutaway drawings, together with brief descriptions, explain the correct way to install Cherry rivets. Illustrations of various pulling heads for both the hand-operated G-10 and G-15 pneumatic riveting guns are also included.

Charts are 20 by 30 in., printed in two colors. *Cherry Rivet Company*, Los Angeles, Calif.

Brazilian Aircraft

Two New Brazilian Light Aeroplanes. Brief particulars of two new Brazilian airplanes are furnished. These are the HL-1 built by the Campanhia Nacional de Navegacao Aérea, a company which has been active for some years, and the C.A.P. 1, the product of the Laminação de Mataes S.A., a newcomer to the aircraft industry.

The CNNA HL-1 is a two-seater dual-control training monoplane fitted with the 65-hp. Continental A-65-8 four-cylinder, horizontally opposed, air-cooled engine. It has a maximum speed of 93 m.p.h. It is stated the company is engaged in the production of 100 of this type for distribution among the Brazilian flying clubs.

The "Planalto" C.A.P. 1 is a two-seater advanced training monoplane with a 90-hp. Franklin horizontally opposed, air-cooled engine and it has a cruising speed of 99 m.p.h. It is stated a first group of ten is being followed by a second series of 50, to be available for sale to private pilots as well as for the use of the national flying clubs. *The Intava World*, July.

Portable Hangar

Hangar on Wheels. Descriptive data are given on a mobile hangar used by Fleetwings for experimental work on airplane power plants. With the framework of the portable hangar made of steel and the covering of canvas, the entire building is mounted on wheels on two parallel double-rail tracks. Heat is provided by means of two large blower units attached to the plant steam supply. *The Fleetwings Arrow*, October, 1943.

Testing Room for Electrical Motors

Caged in Copper. Roland Bradley. This article deals with the copper-lined laboratory in which electric motors for Boeing planes are tested. It describes how the copper walls act as a shield to keep out radio-wave interference and to keep in the special interference of the motors being tested, permitting the motors to be analyzed and measured for special filters and condensers.

A brief note is included on the copper-padded room where regular functional tests are conducted on the radio receivers for Boeing planes. Equipped with the copper lining to exclude electric vibrations, this room is reported to be the only testing ground where all interrupting electrical waves can be screened out for exact scientific diagnosis. *Boeing News*, September, 1943.

Aircraft Instruments

This book, intended to serve as a primary text on aircraft instruments, covers the fundamentals of operation and describes the principal uses of the air-speed indicator, the altimeter, turn and bank indicators, etc. It was written for the purpose of imparting a basic understanding of such instruments and does not cover in minute detail any particular phase of the subject. *Eclipse-Pioneer Division, Bendix Aviation Corporation.*

Mechanical Properties of Plexiglas

The mechanical properties of Plexiglas, as determined in the Physics Testing Laboratory opened last year by the Rohm & Haas Company, are compiled in a new technical booklet. Second in a series of technical booklets covering the optical, mechanical, thermal, chemical, and electrical properties of Plexiglas, *Mechanical Properties* includes details of the test methods, as well as the result, so that engineers and designers may properly evaluate and interpret the given data.

Another feature of the booklet covers applications of specific properties. For instance, specific gravity measurements are given, the test method is detailed, and applications of the property to aircraft and naval construction are discussed. Scratch resistance, indentation resistance, rebound efficiency, and abrasion resistance are among the types of hardness properties covered.

Also described in detail in the booklet are the impact strength, tensile strength, flexural strength, compressive strength, sheer strength, and pinload bearing strength of Plexiglas. Effect of temperature, thickness, size and shape, conditioning, rate of straining, and other factors affecting strength are charted and graphs included.

Modulus of elasticity and cold flow or creep are other properties discussed. An appendix includes optical, electrical, and chemical properties. *Rohm & Haas Company*, Philadelphia, Pa.

Compass Calibration

Keeping 'em Headed in the Right Direction. Frank Casey. This article deals with Lockheed-Vega's Compass Swinging Base. In detailing the procedures of swinging and calibrating compasses as they are carried out by this company, the importance of accurate compass installations is also explained. As described, the base consists of three large circular concrete slabs free of reinforcing steel. One, for the P-38's, has a nonmagnetic cradle with bronze hydraulic jacks to place the airplane in horizontal flight position. Another, equipped with a large hydraulic piston and cylinder in the center, is used to swing the B-17, PV-1, C60, and 414. The third and largest is 120 ft. in diameter. Each base is calibrated every 15° so that the airplanes can be placed exactly on the magnetic headings when the compasses are calibrated. *Lockheed Vega Aircraftsman*, September, 1943.

Aero Safety Starter

A four-page bulletin contains descriptive data on a mechanical starter for light planes. Comparative advantages of cost, weight, operation, and safety are listed. *McDowell Manufacturing Company*, Pittsburgh, Pa.

Buying Data on Motors

Buying data and information on Westinghouse motors and controls have been made available in both bound and loose-leaf form. A 180-page bound book titled *Motor Buying Data* covers motors up to 100 hp., gearmotors, and motor-generator sets. A 276-page bound book titled *Control Buying Data* lists a wide variety of controls and accessories for d.c., single phase, squirrel-cage, and wound-rotor motors.

A loose-leaf book on both motors and controls published for the use of large-scale purchasers contains complete production listings and information on special requirements for specific industries. Special features of the books are a new index system for quick product selection, and a directory of standard equipment designed to eliminate the need for specially built motors and controls. *Westinghouse Electric & Manufacturing Company.*

Welding Positioning Equipment

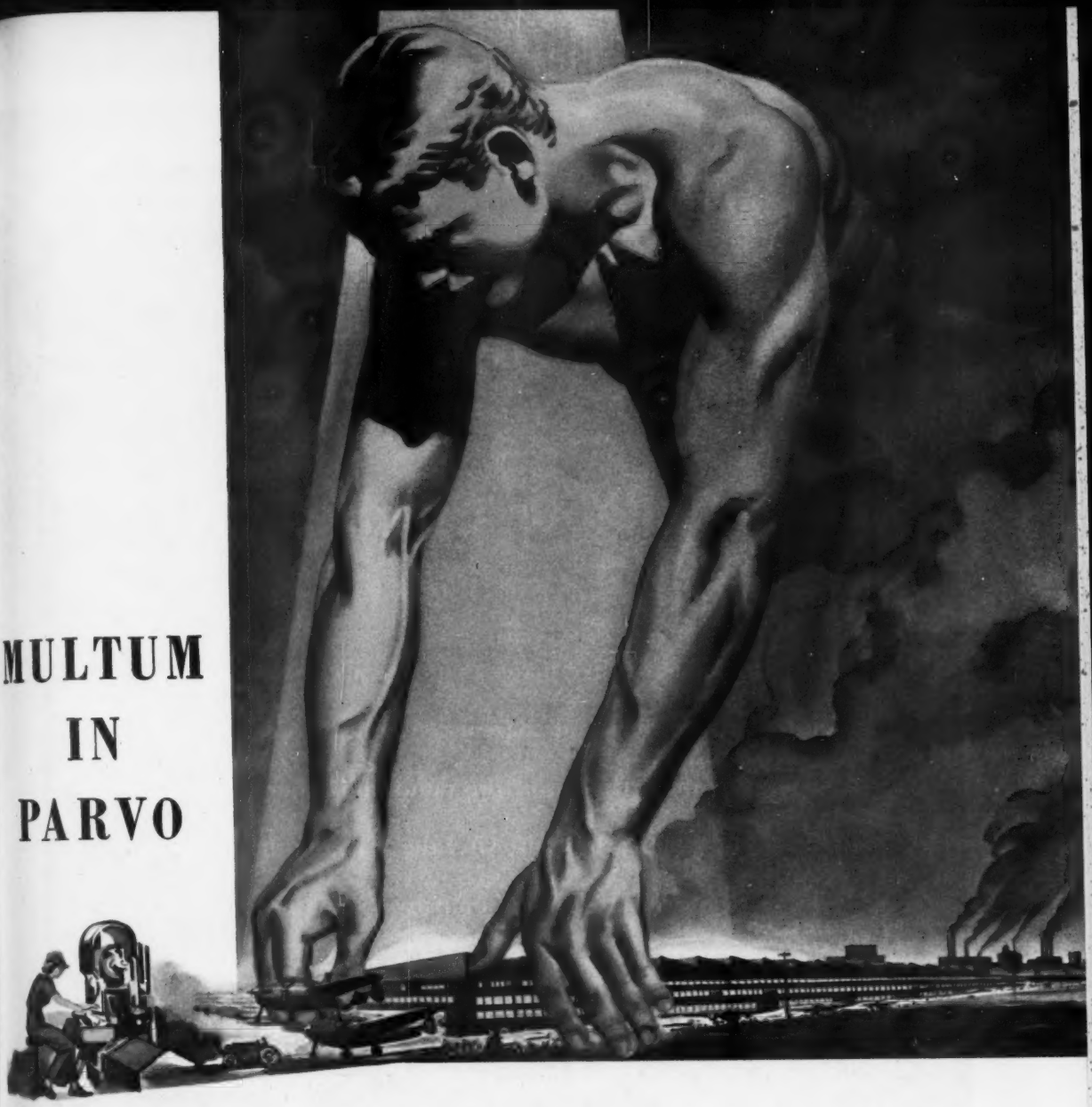
A new 4-page, two-color bulletin No. 201 presents in concise form the full Ransome line of welding positioning equipment. Specifications, important features, load rating tables, and dimensions are included. *Ransome Machinery Company*, Dunellen, N.J.

Book on Welding Stainless Steels

Welding Stainless Steels is the title of a book interpreting the techniques commercially employed and the precautions to be observed in the welding of stainless steel by the accepted processes. The book is not only a practical instruction manual for the student or beginner in stainless-steel welding but also contains technical matter helpful to production men, engineers, designers, and metallurgists engaged in stainless-steel fabrication. Sections cover the effects of heat on stainless steel, metal arc welding, atomic hydrogen welding, oxygen-acetylene welding, electrical resistance welding, and welding Pluramelt steels. *Allegheny Ludlum Steel Corporation.*

Making Corsair Stabilizers

This, Then . . . . . Is a Surface Tale! The principal contribution of the Fleetwings organization to the war effort is defined as the production of tail surfaces for various types of combat airplanes, including the Flying Fortress, the Douglas Havoc, the Brewster Buccaneer, and the Vought Corsair. The article traces the operations involved in the execution of a typical subcontract by the organization for the manufacture of stabilizers for the Corsair. How the Engineering Department originated certain changes in the design which were accepted by the prime contractor and how the work is performed in the Fleetwings plant are briefly related, without attempting to show each detail. The



MULTUM IN PARVO

The old Latin phrase, multum in parvo—"much in little", has attained a significance in World War II far beyond its original meaning. This is particularly true in the aircraft industry, where little things, inventions and developments perhaps small in themselves, have contributed much to Victory—through speeding and multiplying production.

For example, at McDonnell, we use a *vari-angle** attachment to a sander, which saves as much as a third of the total manufacturing time on form blocks—plus largely eliminating danger of deviations.

Using this device, even an inexperienced workman may perform in *15 minutes* an operation which formerly required *four hours.*

This easily operated machine may be used on all types of kirksite, masonite, zinc, and plastic form blocks, grinding steel jigs, beveling hammer forms before they are assembled, and roughing down wood patterns.

Invented by a member of our organization, the vari-angle attachment is not limited to sanders, but can be adapted to any abrading machine—shapers, routers, milling machines, etc.

This is but one of many developments numbered among the achievements of McDonnell personnel. For in their tasks of building planes, parts, and plastics for war, they constantly ask of themselves—as they study each operation—"Can it be done better and faster?"

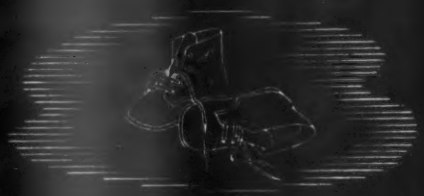
Such time-saving devices as the vari-angle attachment—which can speed certain operations as much as 1600%—constitute a most constructive answer.

We believe the active interest of our personnel in seeking constantly to improve production methods, is responsible in no small part for McDonnell's record of meeting production requirements *on schedule.*

**Pat. Appl'd For. For further information contact your local machinery supplier.*

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES · PARTS · PLASTICS ★ SAINT LOUIS - MEMPHIS ★



How Will Your Children Live?

That's easy! They'll live better than you just as certainly as you live better than your parents. American industry has put the car, the refrigerator, the radio and other conveniences within the reach of all. After the war, the three-plant facilities of the Weatherhead Company will be prepared to help you build these products again and — mark this! — many strange new devices which one day will make your life, and your children's lives, pleasanter in scores of ways.

Look Ahead with

Weatherhead

THE WEATHERHEAD COMPANY, CLEVELAND, OHIO
Manufacturers of vital parts for the automotive, aviation, refrigeration and other key industries.

Plants: Cleveland, Columbia City, Ind., Los Angeles
Canada—St. Thomas, Ontario

functions of the spot-welding departments are described, and the work is followed to the main assembly departments. The six operations through which the stabilizer passes on the mobile assembly lines are recounted. *The Fleetwings Arrow*, September, 1943.

New A.S.T.M. Standards

Many important actions on standards were taken by Standards Committee E-10 of the A.S.T.M. at its meeting at A.S.T.M. Headquarters on August 30, and other standards also had previously been approved. The number of new specifications and tests, including emergency standards, totals 17, while 23 standards and tentative specifications were involved in regular and emergency revisions approved by the committee. Of particular significance to the various industrial groups are the following: comparison test for color of Army motor fuel; three new specifications covering clad plate (stainless sheets bonded to steel plates); several specifications for nonrigid plastics of various compositions; new hardness conversion tables for steel; and two new emergency specifications for insulated wire and cable with synthetic rubber compound.

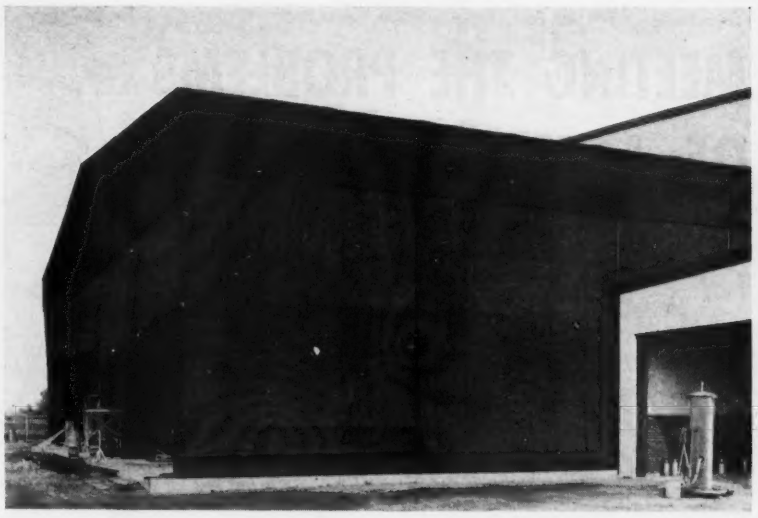
Through the work of a special group in its Section on Indentation Hardness, A.S.T.M. Committee E-1 on Methods of Testing completed the new Tentative Hardness Conversion Tables for Steels (E 48–43 T) giving relationship between diamond pyramid hardness, Rockwell hardness, and Brinell hardness. The tables are based on extensive tests on carbon and alloy steels, mostly in the heat-treated condition, but have been found to be reliable on practically all constructional alloy and tool steels in the as-forged, annealed, normalized, and quenched-and-tempered conditions, provided they are homogeneous. Such special cases as high manganese steel, 18 per cent chromium, 8 per cent nickel steels, and other austenitic steels, nickel-based alloys as well as constructional alloy and tool steels in the cold-worked condition, may not conform to these relationships with the same degree of accuracy as the steels for which they are intended.

This is the second standard giving conversion tables developed by the special committee; the first covered cartridge brass (E 33–42). The new tables covering steel are the result of cooperative efforts with the Society of Automotive Engineers and American Society for Metals.

An emergency action involving electric-resistance-welded heat-exchanger and condenser tubes, EA-A 214, will permit the use of an electric tester in lieu of the hydrostatic test, and also in the interest of increased production the consumer may permit unnormalized material with consequent modifications in the flattening and hardness test. The electrical tester that can detect small defects that either partly or completely penetrate the tube wall was developed by Republic Steel Corporation, Steel and Tube Division, using a basic Sperry process. Large amounts of the tubing inspected by the electric tests have been fabricated.

The latest in the series of important specifications and tests for plastics developed through the intensive work of Committee D-20 covers the so-called nonrigid type of plastics. The six tentative standards approved by Committee E-10 cover the following: Nonrigid Polyvinyl Chloride-Acetate Plastics (D 742–43 T); Nonrigid Ethyl Cellulose Plastics (D 743–43 T); Nonrigid Polyvinyl Chloride Plastics (D 744–43 T); Nonrigid Polyvinyl Butyral Plastics (D 745–43 T); Tentative Method of Test for Stiffness in Flexure of Nonrigid Plastics (D 747–43 T); Tentative Method of Test for Brittleness of Nonrigid Plastics (D 746–43 T).

In addition to these new tentative standards, there were approved several modifications in specifications approved earlier this year. In the case of polystyrene molding compounds (D 703) a new type 3 material has been added which is a general purpose molding material characterized by superior heat-resistant qualities. *American Society for Testing Materials.*



A Fleetwings' mobile hangar. The curtains can be raised or lowered as weather conditions demand. (*See* page 156.)

Foundry Equipment

A revised edition of *The American Line*, a 20-page reference catalogue of American Foundry Equipment products has been issued. Information is given on airless blast cleaning equipment, metal washing machines, dust collectors, wet disposal units for dry-type dust collectors, sandcutters, rod straighteners and blast nozzles.

Included in the catalogue are operating views of typical installations in industrial plants. *American Foundry Equipment Company*, Mishawaka, Ind.

Six-Year History

Saga of Vega. Bernice K. Platt. A brief history of Vega Aircraft Corporation. The development of the company is traced from its founding in 1937, under the name of AiRover Company, until the present date. All of the various aircraft and components which were built by Vega during the six years are named. *Lockheed Vega Aircraftsman*, September, 1943.

All-Metal Cargo Carrier and Its Predecessor

Army Cargo. Some notes on the development of Fairchild air-cargo carriers, indicating the influence of the first Fairchild cargo plane, the C-31, upon the latest all-metal, twin-engined, high-winged Fairchild carrier type. Information is given on the C-31. With regard to the new cargo plane, however, although some conception of its general purpose and appearance is given, the article states its specifications are not available for dissemination. The report is that it was designed primarily for maximum cargo space, ease of loading, and the ability to operate from fields of limited size. Its engineering plan was for a plane that would be capable of a maximum range of 3,500 miles while carrying a maximum pay load. *The Pegasus*, October, 1943.

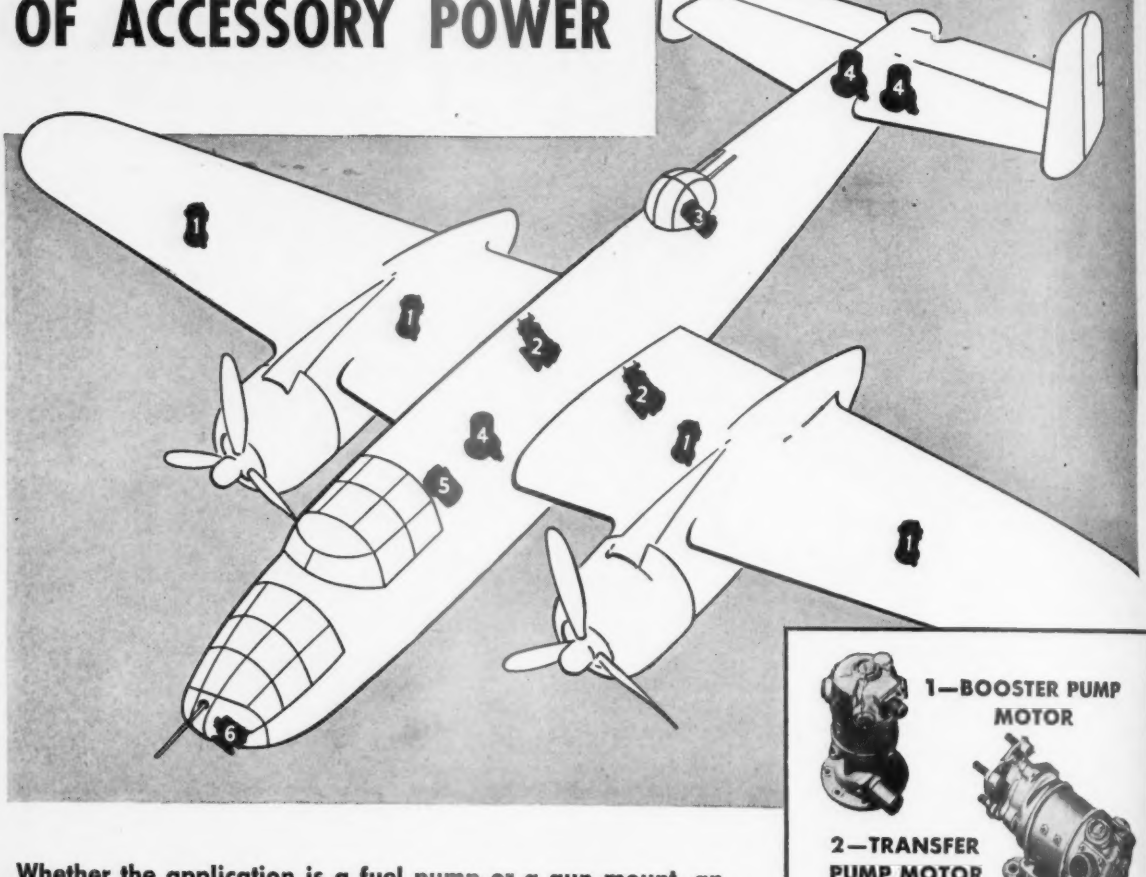
Industrial Pumps

Westco pumps, manufactured for a wide variety of industrial applications, are described in a catalogue designated by the manufacturer as No. 43. A detailed description of the various models is furnished. A brief description of the company's line of Pomona pumps also is furnished. *Pomona Pump Company Division of Joshua Hendy Iron Works*, Pomona, Calif.

National Aircraft Standards

Additional sheets have been issued for insertion in the National Aircraft Standards files. New sheets cover NAS42 on rivet spacers, and NAS43 on screw and bolt spacers. Revised sheets

MEETING THE PROBLEMS OF ACCESSORY POWER



Whether the application is a fuel pump or a gun mount, an instrument or a windshield wiper, Delco aircraft electric motors represent an efficient solution to the power problem. Each is designed with special consideration for space and weight limitations—each is built to the high standard of precision which airborne operation demands. Delco Products' engineering and manufacturing experience has been applied in full measure to the satisfying of the accessory motor requirements of the aircraft industry. Delco Products Division, General Motors Corporation, Dayton, Ohio.

EVERY WAR BOND PURCHASE BRINGS VICTORY CLOSER

DELCO MOTORS

DELCO PRODUCTS *DIVISION OF* **GENERAL MOTORS**

cover NAS27 on tank strap turnbuckles and NAS53 through NAS66 on close-tolerance bolts.

Another group includes 23 new data sheets and one revised sheet, on screws, nuts, couplings, and steel and plastic tubes and fittings. A list of sources of supply for National Aircraft Standards items is included. *National Aircraft Standards Committee.*

Uses for Wool Felt

The story of felt for both civilian and war uses is told in a 22-page book titled *Felt Facts.* It is noted that although wool felt is thought of most frequently as a springy, spongy substance it can be pressed to almost any consistency. Unlike textiles in which spun and twisted fibers are guided by weaving or knitting into a predetermined pattern, the fibers in felt are "teased" into an almost self-selected arrangement without distortion of their natural twists and bends.

Another important virtue ascribed to felt is that it can readily combined with certain natural substances and synthetic plastics.

The manufacture of felt is described. A partial list of the military uses of felt is given. Included in the list are 20 aviation uses. *The Felt Association, Inc.*, New York.

Booklet on Agitators

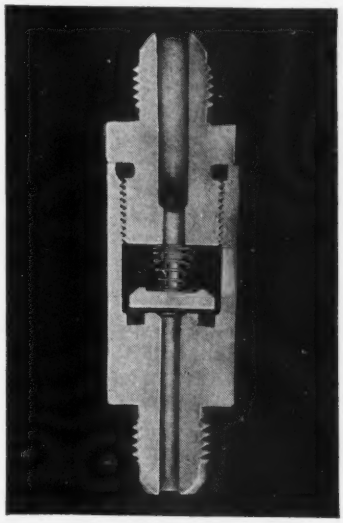
A booklet titled *Pneumix in Action* has been issued to show Pneumix agitators in use on different types of work. One illustration shows a Type B agitator used for mixing various grades of oils to the proper consistency for the lubricating and cooling of high-speed tools employed in the manufacture of aircraft engines. In addition to the illustration, information on the company's complete line of agitators is included. These agitators are operated by compressed air to eliminate fire hazard. *Eclipse Air Brush Company, Inc.*, Newark, N.J.

Electric Furnaces

Types of General Electric furnaces for various applications are classified, described, and illustrated in a 76-page catalogue titled *Electric Furnaces.* Included is information on furnaces for working aluminum alloys, annealing copper, brass, malleable iron, steel, glass castings and parts, brazing, carburizing, drawing, and hardening. *General Electric Company.*

Gases for Heat-Treatment

Westinghouse Heat Treating Atmospheres is the title of a 15-page catalogue containing information and data on Endogas, Exogas, Monogas, and Ammogas, which provide four basic gases from which nine variations may be obtained to select the proper atmosphere for heat-treating process. Applications of the gases are outlined and the equipment manufactured for their use is described. The composition of the gases is given and curves show the chemical



Electrol Incorporated's new check valve. (*See* page 169.)

reactions. Applications of the gases include annealing, brazing, hardening, tempering, gas carburizing, sintering, and normalizing. *Westinghouse Electric & Manufacturing Company.*

Aircraft-Engine Manufacture

Information about Ranger engines, the service they are performing, and the organization that builds them is contained in a 51-page illustrated handbook entitled *Working Together for Victory.* A chart shows the expansion of the plant, personnel, and production from 1940 to 1942. A brief description is given of the various models of engines produced. Some military aircraft equipped with these engines are illustrated. *Ranger Aircraft Engines Division, Fairchild Engine and Airplane Corporation.*

Ball-Bearing Catalogue

Specifications and other information on annular ball bearings have been published in loose-leaf catalogue form. Both single- and double-row ball bearings are listed, including heavy-duty types. *The Schatz Manufacturing Company,* Poughkeepsie, N.Y.

Aircraft Manufacture

A booklet has been published depicting the facilities and activities of Interstate Aircraft. The history of the organization is outlined. Illustrations show complete airplanes and parts, and views in the plants reveal manufacturing operations. *Interstate Aircraft and Engineering Corporation.*

Inspection Instruments

A folder describes the model 80 Norleco Searchray electric inspection instrument. This X-ray unit is designed for the inspection of assemblies, light alloy castings, plastic and hard-rubber moldings, dielectric materials, and other industrial products. *North American Philips Company, Inc.*, Dobbs Ferry, N.Y.

Aircraft Icing

A Report on Ice Accretion. This report is based on a study of an unusual and serious form of icing which was experienced in the westbound flight of an air transport plane between Wichita and Amarillo on March 5, 1943. It covers the flight history, an analysis of meteorologic factors, a synoptic analysis, the history of other flights, and conclusions. *Technical Note No. 7, Transcontinental & Western Air, Inc.*

Thermoplastic Molding Powder

The properties and characteristics of a new type of Lucite molding powder are described in a 10-page booklet. It is stated that with this new powder molded articles can be produced which have yielded temperatures 30° to 40°F. higher than articles molded from commercially available thermoplastic molding powders. It is explained that the transparency, weather resistance, good electrical properties, low specific gravity, and ease of molding of Lucite are retained in this new formulation. *E. I. du Pont de Nemours & Company (Inc.), Plastics Department,* Arlington, N.J.

Self-Balancing Die Sets

A 4-page bulletin describes a self-balancing die set that is designed to increase the range of work that can be done on press brakes and to make practical their use for many stamping and blanking operations on large-sized sheets or plates. A recent improvement in design noted by the makers consists of a "link pivot," added to absorb the stresses that would cause excess strains in the leaf springs. *Leslie Welding Company,* Chicago, Ill.

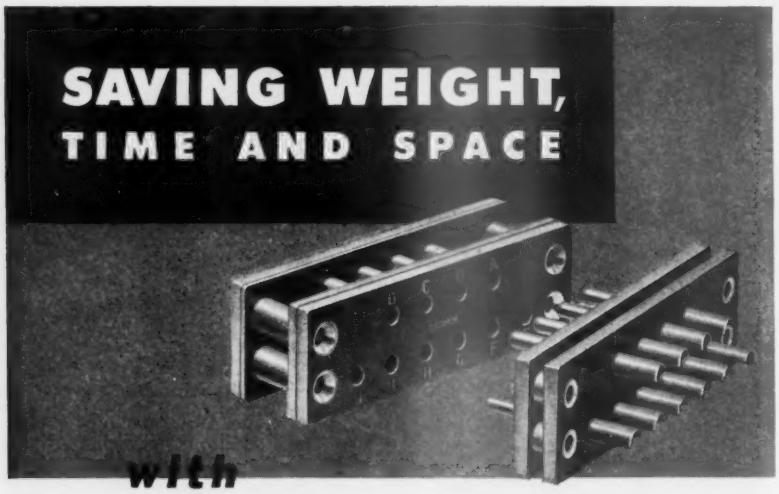
Free College Training for Aircraft Working

"SMWT." The Engineering, Science, and Management War Training program is outlined. As defined, the program provides college-level training, supervised by colleges in industries essential to the war. This article is particularly concerned with the courses given at the University of California for which Lockheed-Vega employees and prospective employees are eligible. *Lockheed Vega Aircraftsman,* September, 1943.

Cleaners and Polishes for Plexiglas

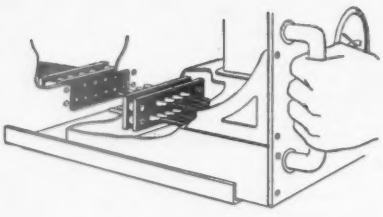
The makers of Plexiglas have recently examined and tested various cleaning and polishing compounds offered for use on that product. Recommendations based on those tests are incorporated in a bulletin that gives advice on substances that should not be used for cleaning, as well as the liquids and waxes that were found to be satisfactory.

The four tests to which the materials were subjected are described, and several commercial polishes are rated



with

CANNON PLUGS



This panel connector is one of the Cannon DP series. It was developed primarily for use on radio and instrument plug-in equipment where weight, space and convenience of operation are often prime considerations.

Both halves of this connector are mounted rigidly. One half mounts on the back of any electrically operated unit. The other half mounts on a rack or panel designed to hold the unit. By this means the excess weight of terminal strips and slack in the cable are eliminated.

In addition to saving weight, Cannon DP Connectors offer many convenient and time-saving advantages in servicing operations.

24 page bulletin with drawings and engineering data on DP connectors available on request. Address Department A-105, Cannon Electric Development Co., Los Angeles 31, California.

CANNON ELECTRIC

Cannon Electric Development Company, Los Angeles 31, Calif.

Canadian Factory and Engineering Office: Cannon Electric Co., Limited, Toronto

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according to the results of the tests. Instructions are given covering the proper methods for cleaning and polishing Plexiglas and reducing surface scratches. The recommended cleaners and polishes are listed. *Rohm & Haas Company*, Philadelphia, Pa.

Porcelain Enamel Finish

A booklet of 24 pages titled *Porcelain Enamel, the "Lifetime Finish"* contains data on the use of porcelain-enameled iron. Engineering information is included which pertains to the abrasion and friction resistance, weather resistance, resistance to chipping, resistance to thermal shock, color fastness and range, finishes available, chemical resistance, and physical properties of porcelain enamel. Its physical properties are compared with those of many other materials: glass, ceramic white ware, thermosetting plastics, hard rubber, aluminum and its alloys, nickel, copper, zinc, iron alloys, and cast iron.

The importance of a highly refined sheet iron with special surface characteristics and physical properties best suited for porcelain enameling is the subject of another section. In addition, there is a brief explanation of the methods of making porcelain enamel and a "bird's-eye view" of the porcelain enameling industry and its production facilities. *The American Rolling Mill Company*, Middletown, O.

Visual Training Aids for Aviation

A new type of catalogue-directory, classifying a wide range of visual aids now available for aviation and aeronautical training, has been published. By a system of indexing, cross-indexing, and classifying varied teaching slide films and motion pictures for aeronautical use, the instructor is enabled more quickly to locate the film subject wanted. In addition, a "preview" of each slide film and motion picture is provided.

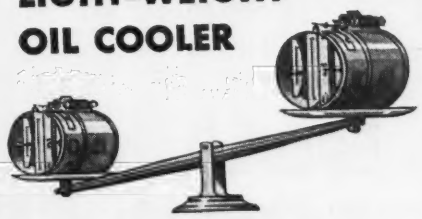
The directory is printed in color, totals 80 pages, and contains information including the number of frames (pictures) in each slide film, describes the pictured material, and gives the total number of individual pictures in each series. Another feature shows which types of projectors are best adapted to various aviation training purposes. *The Jam Handy Organization*, Detroit, Mich.

Instrument Flying

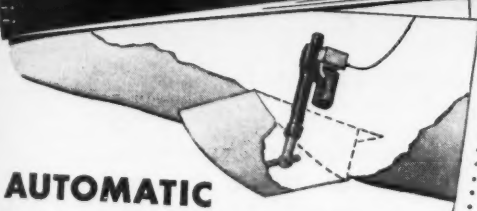
Flight by Instrument. A brief nontechnical explanation of instrument flight contains illustrations and concise descriptions of the eight fundamental instruments used. These are: rate-of-climb indicator, artificial horizon, altimeter, automatic direction finder, directional gyro, bank and turn indicator, air-speed indicator, and automatic pilot. A perspective diagram demonstrates the method of carrying out a typical instrument approach to an airport with the aid of a lettered description of each phase of the operation. *Speed*, Vol. 6, No. I.

AiResearch "FIRSTS" IN OIL COOLING

LIGHT-WEIGHT OIL COOLER



AiResearch pioneered two weight-reducing developments: An especially sturdy light metal construction and new designs giving greater cooling efficiency per square foot.

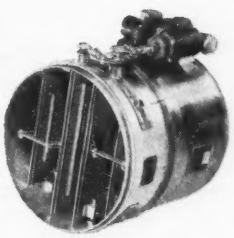


AUTOMATIC EXIT FLAP CONTROL

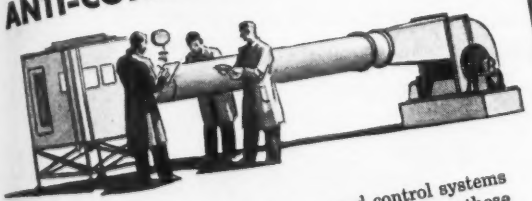
for air ducts. Completely eliminating manual operation and cutting open-flap time considerably, this AiResearch-developed system reduces cooling drag... adds speed. It helps forestall congealing... adds *safety* to American warplanes.

AUTOMATIC SHUTTER CONTROL

AiResearch helped perfect the temperature and pressure-measuring devices that automatically regulate shutter positions —controlling the flow of air through the cooler according to the condition of the oil. And was first to produce these improved oil coolers in volume!

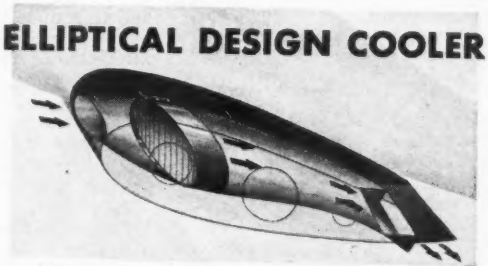


ANTI-CONGEALING COOLER



Many hundreds of oil cooler designs and control systems have been tested in AiResearch laboratories. From these experiments have recently come a new principle of "surge-protection". And an *oil cooler that resists congealing* — even in the most extreme high-altitude colds.

ELLIPTICAL DESIGN COOLER



AiResearch now has this "oil cooler that couldn't be built" in volume production. It is making possible greater freedom of aircraft design...simplified installation...important savings in weight and space.

AIRESEARCH engineering has made scores of other contributions to oil cooling. Still more are coming. For the improvement of heat transfer and pressure control systems is a never-ending project here. Inquiries from aircraft manufacturers and designers on newest AiResearch developments are invited.

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LOOP FITTINGS

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You can now obtain a highly desirable substitute for the hand-spliced loops you have been using.

It is important to consider—under current production pressure—that complete control assemblies using the new **TRU-LOC Center-Pull Loop Fittings** represent a considerable reduction in the labor required for hand splicing. Also, the use of these fittings assures a precision rarely achieved by the most experienced hand splicers.

Of great value to you is the fact that **TRU-LOC Center-Pull Loop Fittings** permit the application of loading stresses in a straight line—a line extending the axis of the cable exactly bisecting the loop. This avoids a condition induced if the pull load on the loop is not in a straight line with the pull of the cable—the setting up of unequal stresses in the cable where its straight portion departs from the fitting. These stresses tend to reduce the strength of the cable at this point.

Write our Detroit office for prices and delivery dates on complete control assemblies. Send specifications and production schedules.

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From the Industry

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Diamond Abrasive Tools

An exclusive numbering feature is designed to eliminate the danger of careless disposal of diamonds before the end of their useful life in diamond tools. Tool No. 15, typical of the cluster-type series, contains 15 fine, whole, natural diamonds arranged in three layers of five each. The diamonds are precisely spaced and staggered to provide maximum contact with the wheel at all times.

Clearly stamped on the head of each tool is a series of figures denoting the number of diamonds in each layer. As the tool is used, the number of diamonds remaining in the tool is indicated through each stage of wear. In this way the danger of the tool being discarded before all the diamonds have been completely used up is avoided.

Characteristic of all of the maker's diamond tools, the exclusive "Oxide-Free Process" combines a new alloy and firing technique that is intended to provide a permanent setting for the stones and to insure useful work until the stones wear out in service. Abrasive Dressing Tool Company, Detroit, Mich.

Portable Spark Plug Testing Unit

A portable spark-plug testing unit, designed to test and overhaul BG, Aero, Bendix, and A.C. aircraft spark plugs in the shop or field, is operated by a $^1/_8$-hp. electric motor. It has a hand crank for use when 110-volt power is unavailable and a hand-pressure test bomb to supplement the carbon-dioxide supply. The unit also includes a point-setter electrode adjuster.

A newly designed top, held in verticle position by steel supports, includes two built-in racks capable of holding 38 spark plugs. The cabinet, including all necessary tools, weighs 84 lbs. and is 26 in. wide, 12 in. deep, and 19 in. high. Airplane Manufacturing & Supply Corporation, North Hollywood, Calif.

Film on Welding Stainless Steel

A motion picture titled *Welding Stainless Steel* was made to serve as an aid in teaching welding students, as well as welders familiar with carbon steel welding, the fundamentals of working with stainless steels.

While primarily produced to explain stainless steel welding in simple terms that a shopman can understand, there is much to interest the experienced metallurgist or engineer in this 16-mm., full-color sound film. It shows close-ups of the arc at work, greatly magnified so that the action of the protective flux and the melting of the rod metal can be clearly seen.

The action of the picture begins with a comparison of the basic differences between the metallurgic characteristics of that alloy and ordinary steel. From there the audience is shown, step by step, the preparatory work necessary to complete good, sound, weld joints, with warnings given about danger points. Laying beads with one pass of the arc and two-sided welding, as well as multiple-bead welding on heavy gauges, are explained and further clarified by appropriate charts.

This two-reel film, which takes about 25 min. to show, is available without charge to companies, trade or technical groups, industrial schools or colleges, or other organizations of like character. Allegheny Ludium Steel Corporation, Brackenridge, Pa.

Sample Card of Felts

A card containing actual samples of the 16 standard grades of Aerofelt has been issued for the assistance of designers, engineers, and purchasing agents interested in the possibilities of using felt as an alternate for critical materials in the manufacture of structural parts.

The Aerofelt line comprises S.A.E. felts coated with rubberized compounds, synthetic rubbers, resins, asphaltums, etc. Strips, washers, grommets, and intricate parts, cut to specification, are being used as alternates for parts formerly made of rubber and other critical materials.

Among the more common applications of the material in the aircraft industry today are fuel-tank mountings, grommets, gaskets, fume gaskets, gas-tank straps, cushions for the domes of bomber turrets, insulation on fire-control instruments for the U.S. Navy, and weatherstripping bomb doors and seals for escape hatches. The American Felt Company, Glenville, Conn.

Self-Contained Aircraft Heater

An aircraft heater that operates independently of engine heat and without the extensive use of ducts is designed for defrosting bombsight windows, gunsight windows, navigation dome, and side blisters or for warming the bombsight, gyro instruments, battery compartment, and turret mechanisms.

The heater is attached to an electric blower or ram air duct and delivers from 600 to 6,000 B.t.u. per hour (depending on the specific application). It has a two-piece shell of lightweight aluminum with a heating element wound on a ceramic core locked to the shell by fillister-head machine screws. The entire unit is constructed to withstand the maximum vibration conditions encountered in aircraft applications. The heater operates on 24–28 volts d.c. and can be designed for any specific application. Avia Products Company, Los Angeles, Calif.

Cabin-Type Thermostats

Barber-Colman cabin-type thermostats have been designed for the control of temperature in aircraft cabins and similar compartments.

The temperature-sensitive element consists of a bimetal coil mounted on a flexing hinge. The entire operating assembly is spring suspended on a Bakelite base and enclosed within an aluminum case which can be readily grounded. A rotating dial provides temperature setting and is visible through the front of the case. For those applications which require the control of temperatures that are served by dual heaters, the installation is also available in a duplex model. Barber-Colman Company, Rockford, Ill.

Improved "Section" Heat Exchanger

An improved construction of the "Sectional Hairpin" heat exchanger, is claimed to offer advantages not before available in these devices. One feature is a nonremovable rear end assembly. The operator is required only to remove the bolts, back the cover plate off far enough to clear the plates of the adjacent section, then swing the plate through a 180° arc and rebolt it in this position to gain unobstructed entrance into the exchanger. This accessibility

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to the interior of the unit permits hairpins employing plain longitudinal, or cut and twisted Fintubes having different ratios of secondary to primary surfaces and different heat transferring capacities to be interchanged one for another as desired, so that a single "stand" of these improved sections can be used for a variety of different duties.

The new head seal introduced in these exchangers, consisting of a solid ring and two split collars tightened with cap screws, can be assembled with a conventional 8-in. crescent wrench. This construction is said to avoid any outboard stress on the split-ring lock. In addition, these exchangers have welded one-piece hairpins which are designed to prevent any mixing of the tube-side commodities. The Brown Fintube Company, Elyria, O.

Indicator Tester

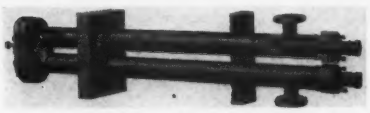
A device called the Clarkator for checking the accuracy of dial indicators employs the sine bar principle, checking against the tangent of the angle. The indicator to be tested is mounted on the top of the instrument with its spindle resting on a lapped angle block, which is advanced or retracted by a screw. After clamping the indicator in position so that its zero reading coincides with the dial face on the testing device, the screw is revolved in either direction to check other indicator readings. The dial is read by means of a mirror, enabling it to be seen together with the indicator.

The Clarkator is said to be suitable for receiving and periodic inspection of both the standard direct-reading indicator and the reversed-reading indicator used on Rockwell hardness testers. The front angle is used when checking standard indicators, each revolution of the screw equalling 0.020 in. and each point on the dial equalling 0.0002 in. The back angle provides a direct method of checking hardness-tester indicators, each revolution of the screw equalling 0.01962 in. Clark Instrument Inc., Dearborn, Mich.

Air-Operated Collet Fixture

The Red-E-Air Chuck is an air-operated collet-holding fixture, used principally for the accurate chucking of screw machine parts for second operation work on drill presses, tapping machines, milling machines, etc., and for drilling, tapping, reaming, threading, chamfering, burring, counterboring, and similar operations.

Standard Brown & Sharpe collets are furnished which chuck work in line with machine spindle despite variations in diameter of the work. The tool is operated by a foot valve, leaving the operator's hands free to load and unload. Through a leverage action, the holding pressure at the collet is multiplied to more than 10 times the air-line pressure. The No. 0 size takes work up to $^7/_8$ in. in diameter. Cleveland Airtool Company, Cleveland, O.



The Brown Fintube Company "sectional hairpin" heat exchanger.

Automatic Circuit Tester

The Rotobridge automatic tester for use with all types of electronic equipment is designed to enable unskilled workers to make high-speed tests for circuit wiring errors, proper resistance, capacity, and inductance values. It automatically locates trouble so that unskilled service workers can rapidly correct wiring errors or replace incorrect or defective components.

The unit operates in the following manner: Two tests are made—the first with d.c. on the bridge and the second with two audio frequencies applied to the bridge. As the starting button is pressed, a motor turns the switch arm at a rate of one circuit per second. At this time d.c. is applied to the bridge and a pilot light labeled "Resistance" lights on the control panel. In this position all resistance tests are made. As the "start" button actuates a stepper-type relay, pushing the button again will cut off the motor and stop the arm at any desired contact point. As the arm revolves it also turns a large disc which is furnished with a numbered scale that is visible through the window in the front panel. This tells the operator which circuit is being tested.

For the resistance test, the bridge is connected to a special circuit that is insensitive to a.c. pickup on the cables or to capacity changes. This bridge output, after suitable amplification, is applied to a thyratron grid which operates a relay that trips if the resistance value is incorrect or if a blank socket terminal is shorted, etc. When this happens the motor shuts off, and a brake is applied stopping the arm rotation immediately and lighting a "reject" lamp. The operator here notes the number of the defective circuit on the inspection card. He then resets the reject relay, which starts the motor drive, and the resistance tests continue.

When the last d.c. test is made, the a.c. or reactance test can be made. The operator can do this by pressing the button marked "reverse," or the Rotobridge will do this automatically if desired. Around the periphery of the indexing disc, space is provided to plug in two projecting stops. These are arranged so that when they revolve on the disc they will actuate a microswitch. The microswitch is connected in multiple with the reverse switch. This circuit is arranged so that at the end of the resistance test, when the microswitch is closed, d.c. is removed from the bridge and the two audio frequencies are then applied. At the same time the first motor is cut off, another motor starts which reverses the direction in which the switch arm travels. The switch arm now retraces its path, checking all of the circuits for capacity or inductance variation or omission. The second projecting stop is placed on the disc to close the microswitch when the rotary arm gets back to the first circuit to be tested for resistance. When this occurs, the motor is automatically cut off and the Rotobridge is ready to test another set. In the a.c. test, the same procedure is followed as in the d.c. test.

With 120 circuit tests possible, a 15- or 20-tube television or radar chassis may be checked. A number of sets with any number of circuits (the total not to exceed 120 circuits) may be tested with one Rotobridge. Communication Measurements Laboratory, New York.

Variable-Frequency Electronic Generator

The CML 1400 variable-frequency electronic generator was developed to fill the need for a versatile source of power, especially for engineers requiring test power at various loads through a wide frequency range. It is designed to deliver power with good regulation and waveform over a frequency range of 300 to 3,500 cycles. Aircraft radio installations can be tested in the plane or serviced in the repair shop without resorting to aircraft power supply. The device may also be used for testing transformers and condensers.

This electronic generator includes a variable-frequency oscillator, followed by several driver stages. The output stage employs a pair of 833-A tubes in Class B. A special control circuit is provided to maintain output voltage at a substantially constant level from no load to full load. Power output is 1,400 watts at 120 volts root mean square value, with a load of unity power factor. Communication Measurements Laboratory, New York.

Tap Reconditioner

An improved design of tap reconditioner is featured by a new spindle head that accommodates interchangeably a wide range of motor types for the various service voltages, phases, and frequencies required. Rigidity of the spindle head plus continuous adjustability for grinding tool wear are provided in the design by mounting the spindle assembly on large dove-tail ways in the pedestal base. The tap chamfering unit, located at left of the machine, is of the precision collet type and has been improved to facilitate changing of taps and collets and to assure maximum locating accuracy. It will accommodate collets from the smallest machine screw size up to the $1^1/_4$ in. standard tap shank size, including long shank taper taps. Spiral pointing and spiral point polishing operations can be performed by integral units of the machine, the former driven from the new spindle.

Internally wired and terminating in a line switch at the base, the $^1/_3$-hp. spindle motor is controlled by a manual

No wonder he rode a brewery horse

WHEN the iron man of old rode forth to battle, he jogged along at a pretty conservative gait. What with his hand-wrought and riveted riding habit, chain-mail underwear, broadsword, lance, et al, his steed had to be built for heavy-duty rather than speed.

That was the price he paid for protection. Perhaps it wasn't too high then, but it would be today. Our modern "cavalry of the air" has the superlative protection of Hycar synthetic rubber in bullet-sealing tanks and hose, in hydraulic seals and diaphragms. At the same time Hycar is light—saves 20% to 25% in weight over many other synthetics, and its resistance to oil-absorption keeps it light. Speed, range and payload are the beneficiaries.

Aren't these the qualities you have wanted in oil and fuel hose, hydraulic lines, seals, gaskets, grommets, diaphragms and other resilient products you use? *Hycar Chemical Company, Akron 8, Ohio.*

***LIMITED QUANTITIES OF HYCAR** are now available to your rubber products supplier for experimental purposes without WPB allocations. This material may be used in the development and test of products for both present and future manufacture. It enables you now to gain actual experience with Hycar in many applications heretofore not permitted under war restrictions, but which may be vitally important to your post-war plans. Our technical staff and laboratory are ready to help.*

Hycar

LARGEST PRIVATE PRODUCER OF BUTADIENE

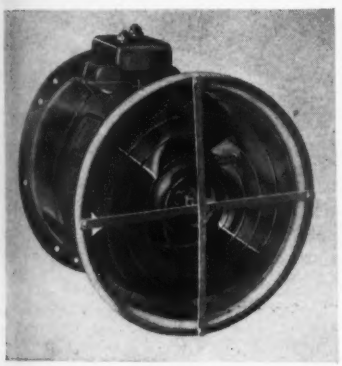
Synthetic Rubber

switch mounted in the base. Standard motors are for 220- or 440-volt, three phase—or 110-volt, single phase—either 25- or 60-cycle service. Detroit Tap & Tool Company, Detroit, Mich.

High-Pressure Axial Flow Fan

A single, two-blade fan installation for recirculation of cabin air through combustion heaters, for use on medium and heavy bombers, designated as catalogue No. 586-B, is powered by a 1/8-hp., series-wound 24–28-volt motor and delivers 320 cu.ft. per min. of air at sea level against 2-in. water gauge pressure or 450 cu.ft. per min. against 1 1/2-in. pressure at a 20,000-ft. altitude.

With the power increased to 1/2 hp. and a second propeller added on a double-extended shaft, the fan is listed as catalogue No. 586-SCB and is designed to move 25 per cent more volume at double the original pressure. Another unit, of 7-in. diameter, is now in the final stages of development and will be designed to deliver approximately 600 cu.ft. per min. at 5 in. of pressure. Dynamic Air Engineering, Inc., Los Angeles, Calif.

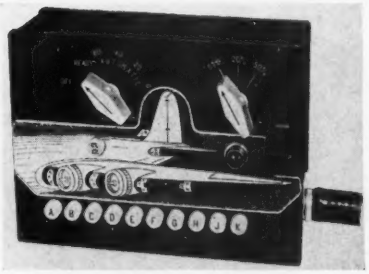


This high-pressure axial flow fan is designed to deliver 450 cu.ft. per min. against 1 1/2-in. pressure at 20,000 ft. when powered by a 1/8-hp. motor.

Manifold-Solenoid Deicer System with Electronic Control

The Eclipse electronic control has been developed for use with the Eclipse manifold-solenoid deicer system, in conjunction with B. F. Goodrich deicers on aircraft with wing spans in excess of 100 ft., to provide a variable control of the deicer system to suit the rate of accretion and the texture of ice formations encountered.

Research and experimentation, substantiated by field experience obtained from mechanical deicer performance, indicate that complete ice removal can be effected by the deicer method, despite the varying ice conditions encountered, provided the accretion of the ice is permitted to develop a tensile strength sufficient to overcome the adhesion between the ice and the deicer boot on inflation. This requires that the deicer system be controlled for both the rate of accretion and the texture of the ice formation.



The Eclipse Electronic Deicer Control.

The Eclipse control is claimed to accomplish this requisite by providing a means of varying the time between deicer operating cycles to compensate for variations in rate of ice formation and also varying the deicer cell inflation to compensate for variations in texture of ice formations. In addition, it provides a visible automatic or manual push-button remote electrical control of wing and tail deicers.

The system consists of electronically controlled solenoid actuated distributor valves located at each deicer boot connection; pressure-type oil separator and air filter; pressure relief valve for limiting the deicer system air pressure; and an electrically controlled unloading valve for unloading the air pumps when the deicers are not being operated. Eclipse-Pioneer Division, Bendix Aviation Corporation.

Check Valve Conserves Critical Material

A check valve made from a minimum of critical materials is entirely a screw-machine product consisting of only three parts. Since it uses no hardened steel and requires no grinding or honing equipment, the makers state that it not only conserves critical war materials and machines but effects a considerable saving in cost. Electrol Incorporated, Kingston, N.Y.

Plastic Covers Protect Airplane Engines

Plastics have replaced aluminum and other scarce metals in covers to protect openings in airplanes and tank engines during assembly and shipment. Made by the Lurite Corporation of Newark, N.J., covers of Plastacele cellulose acetate plastic are being used by Wright Aeronautical Corporation and others to guard against the engines being fouled by dirt or other foreign objects dropping through openings into the cylinders and other vital parts.

The covers are especially made for the openings and are of all sizes and shapes. Approximately 25 different plastic protectors are in use for such openings as the carburetor air inlet, cylinder holes in the crankcase, and exhaust stacks.

The carburetor air inlet cover, measuring 16 by 8 in., is the largest plastic protector in use at present. Other covers include these for the cylinder intake port, cylinder exhaust port, intake pipe-packing nut, exhaust port, and cylinder intake pipe hose connections. Still others are being designed. E. I. du Pont de Nemours & Company (Inc.) Plastics Department.

Sky Freight Loader

The Heil Sky Freight Loader is designed specifically for handling air freight and to provide shorter loading and unloading time for air mail, express, and freight. It is loaded much the same as the standard stake or panel truck and then backed up to the cargo door. The body is hydraulically raised until the floor is at exactly the same height as the cargo door. The tailgate is lowered and cargo is moved from truck to plane.

Twin hydraulic cylinders, controlled either from the truck cab or from the

Designed specifically for handling air freight, the Heil Sky Freight Loader illustrated has a pay-load capacity of 8,000 lbs. maximum.

MODEL	-hp- RESISTANCE-TUNED AUDIO OSCILLATORS	
200A	35-35,000 cps Cabinet mounting Output 1 watt into 500 ohms	$ 95.00
200B	20-20,000 cps Cabinet mounting Output 1 watt into 500 ohms	95.00
200C	20-200,000 cps Cabinet mounting Output 10 volts into 1000 ohms	135.00
200D	7-70,000 cps Cabinet mounting Output 10 volts into 1000 ohms	150.00
202D	2-70,000 cps	250.00

Model 200C

Main frequency from Model 200D

no zero setting

hp Resistance-tuned AUDIO OSCILLATOR

Just three dials on this audio oscillator: range selector, output voltage control and the main frequency dial. This simplicity of design makes for utmost speed in operation and yet there is no sacrifice in accuracy. Of outstanding importance is the fact that no zero setting is required even during the first few minutes of operation. The frequency stability can be depended upon over long periods as well as the accuracy of the calibrations which are for direct reading.

★ Remember these outstanding features: Low Distortion, Logrithmic scale, constant output, no zero setting, simplicity of operation and small physical size which increases their usefulness in all applications. Get complete information about these -*hp*- Resistance-Tuned Audio Oscillators today. A 24-page catalog which gives much valuable information about electronic measuring devices as well as complete technical data on many -*hp*- instruments will be sent you free of charge.

682

HEWLETT-PACKARD COMPANY

P. O. BOX 335-G — STATION A, PALO ALTO, CALIFORNIA

truck body, lift the body of the loader straight up to a maximum height of 120 in. or any intermediate height. In lowered position the body floor is 54 in. high. Pay-load capacity of the unit is 8,000 lbs. maximum—5,000 lbs. normal. The unit is built to withstand a temperature range of 50° to 160°F. The lift operates with scissor-type action. The Heil Company, Milwaukee, Wis.

Welded Cutting Tip on Boring Bar

A redesigned boring bar for boring landing-gear struts for airplanes, devised by Gladden Products, Inc., Glendale, Calif., is reported to save much of the time formerly used to manufacture the bar because of the amount of machining saved. The new design calls for $1^{7}/_{8}$- or 2-in. thick-walled tubing, on which the cutting tip is built up by arc welding using tool steel electrodes. Drilling for an oil hole is unnecessary.

The cost of the boring bars made under the old method of machining amounted to approximately $100. By using the thick-walled tubing and building up the cutting tip by arc welding, the cost of the boring bars now amounts to only $20. Hobart Brothers Company, Troy, O.

Solvent Cleaner for Aircraft Pistons

Magnus No. 756 solvent cleaner was developed for removing carbonized oil from aircraft pistons. Usable at room temperature, this cleansing agent eliminates the need for heated cleaning solutions.

The pistons are immersed in the Magnus No. 756 for approximately 2 hours. At the end of that period, they are removed and rinsed with a pressure stream of water or blown off with steam and then dried by air. The company states that the cleaner has no harmful effect upon metals. It does not cause staining or discoloration of aluminum. Magnus Chemical Company, Garwood, N.J.

Model of Aircraft Electrical System

A major addition to the Navy's battery of special devices is an operating model of the electrical system of the Martin PBM Mariner flying boat. Complete to the smallest wire and only slightly compressed, the model is in use at a Naval Air Station in Florida. By means of the model, only slightly smaller in length and wingspread than the Mariner itself, the Navy trains pilots, copilots, flight engineers, and ground maintenance men in the workings of the airplane's electrical system. The purpose of such training is to give the men who are being trained to fly or service Mariners advance experience in problems they will encounter in combat and maintenance.

The Mariner's entire electrical system is laid out in a simplified wooden mock-up of the plane. In the bombardier's compartment, for instance, are set up the bomb-release system; the bow turret connections; the altimeter; and the rate-of-climb, air-speed, and air-temperature indicators. These instruments are not mock-ups. They are the actual working instruments, and this also holds true throughout the model. In the cockpit are set up the pilot's pedestal and the instrument panel with its various electrical instruments. On the flight deck is the flight engineer's panel.

Under the flight deck, as on the actual craft, are batteries and electrical fuel pumps; in the approximate location of the galley are the two inverters that change direct current to alternating current for the use of those devices that require alternating current. In the tail are the turret interphone box, the domelight junction box, the flare release, and the tail light. Also, as on the actual plane, there is a complete interphone system. The system connects with an instructor posted on a raised platform some yards from the model. Through it the instructor can talk to the student crew manning the various instruments. Leading to the instructor's platform is a series of wires by which he can create the "bugs" that get into electrical systems. By pressing a button or a switch, he can cause lifelike imitations of such defects as loose, broken, or grounded wires; loose terminals; battery or generator failures; and maladjustments of relay units. The student is required to diagnose the trouble and report back by interphone to the instructor what the trouble is and how he would go about remedying it.

The realistic model was built at The Glenn L. Martin Company's plant in Baltimore. Before the model was dismantled and shipped, it was subjected to exhaustive tests at the plant to determine its efficiency as an aid to instruction. A similar one is being made up for use in the Company's own PBM Mariner School, where it will be used in the instruction of ground and flight-test mechanics, ground-test electricians, and electrical-installation and final-assembly preparation personnel. The Glenn L. Martin Company.

Rivets are dispensed in cellophane bags at The Glenn L. Martin Company, Baltimore. This procedure eliminates the handling of loose rivets and the sorting of dropped rivets.

Rivets Dispensed in Cellophane Bags

At the plants of The Glenn L. Martin Company, hundreds of thousands of rivets are dispensed in cellophane bags from racks like those used in selling packaged candy or nuts. Each bag is marked with the type, length, and diameter of the rivets it contains. Men and women working on Marauder, Mariner, and Baltimore bombers now take off a bag at a time as needed instead of reaching into a bin of loose rivets, many of which would formerly be dropped on the floor and have to go through a sorting process before being returned to stock. The Glenn L. Martin Company.

Pneumatic Collet Fixture

Model C-18 pneumatic collet fixture is designed to provide a powerful and accurate grip on round, hexagonal, or square work. Maximum capacity is 1 in. round, $^{23}/_{32}$ in. square, $^{7}/_{8}$ in. hexagonal. An accurate depth stop is provided by means of a hollow ram through which a depth rod of required length rests on the machine table, clear of moving parts. The fixture is furnished with an adapter for connecting the ram to any standard draw-in collet up to 1 in. capacity; a corresponding closing ring is pressed to the top of the housing.

The valve furnished with the fixture may be operated by foot pressure or may be mounted for automatic operation by the machine being used. The makers state that the unit is especially suitable for "high torque" threading jobs. The gripping power is adequate to hold cylindric work of alloy steel while threads are cut on the outside with self-opening die heads or ordinary dies.

The fixture is sealed so that lubricants and coolants may be freely used. An alternate housing is available with sealed openings so that oil may be pumped up through the collet, forming a fountain that washes away chips as they fall. This is known as Model C-180S.

A special base can be furnished containing an automatic ejecting mechanism, also air operated. This mechanism is actuated by a second control valve which can be operated by foot pressure or automatically. Mead Specialties Company, Chicago, Ill.

Light-Plane Construction Film

A film titled *The Construction of a Light Airplane*, photographed at the Piper Aircraft Corporation plant by the film production unit of The Pennsylvania State College's extension audio-visual aids service, follows in detail the construction of a Piper Cub.

The total number of prints now in circulation is 113, and they may be obtained from 82 different film libraries in 44 different states. Chicago, Detroit, Newark, and Pittsburgh are among the city school districts that have purchased this film for their own exclusive use.

It is reported that the film has been included in the bibliography of pre-induction, preflight training films compiled by the U.S. Office of Education and the U.S. War Department. Piper Aircraft Corporation.

Portable Seam-Welding Gun

An air-operated portable seam-welding gun, with which parts that are too big to "take to the machine"—and also large assemblies which are mounted in stationary fixtures—can be seam-welded, is believed to be the first practical portable seam welder available to industry. It is already in use welding 22-ft. seams on disposable lightweight gasoline tanks.

The machine has been designed for welding steel up to two thicknesses of 20 gauge, including stainless steels. The gun is universally suspended and can be swiveled about so that the operator can weld in almost any direction—horizontally or vertically.

Features of this new seam-welding gun include a head operated by an air motor using 42 cu.ft. of air per min. under load. The motor is rated at 2 hp. when run at a constant speed. Its standard speed is between 48 and 52 in. per min. using standard rolls or wheels. A governor regulates the speed of the air motor.

When the seam-welding gun is in operation, the air passing into the handle runs the motor. Pushing the control button, which is located on the guide handle at the right of the gun, operates a solenoid switch, letting the air into the cylinder on the gun. This air cylinder has a diameter of $4\frac{1}{2}$ in., which is large enough to provide a maximum pressure of 1,400 lbs. per sq.in. with 90 lbs. of line pressure. This permits the seam welding of stainless steel.

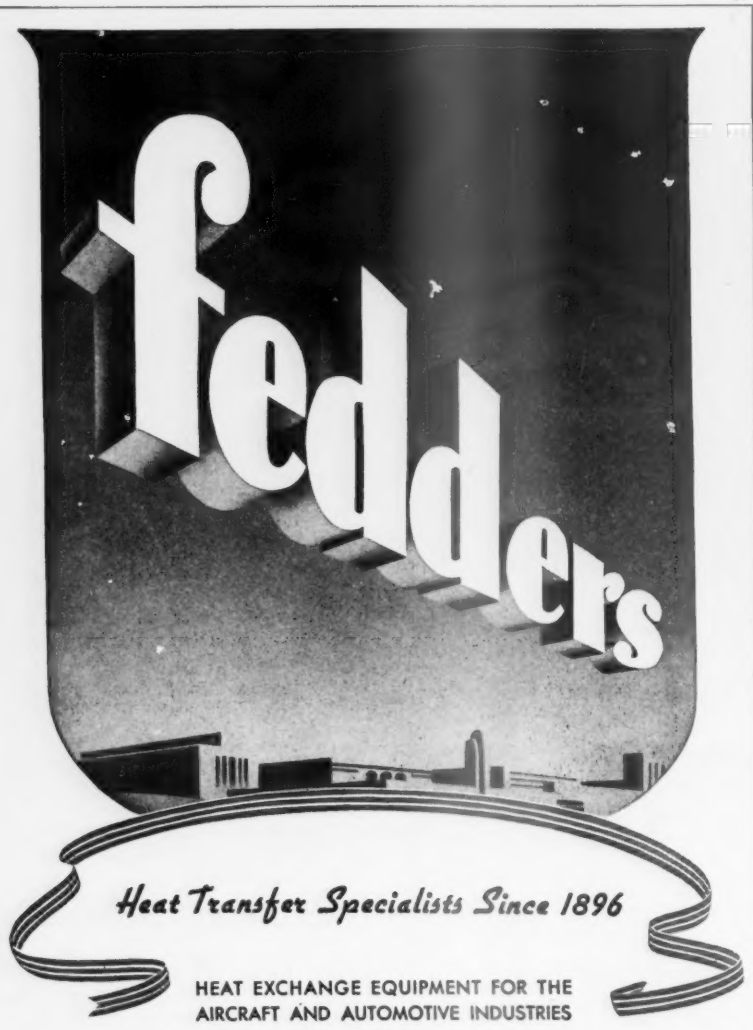
The air flowing into the cylinder forces the upper and lower wheels together. The upper wheel is the idling wheel; the lower is the driven. When the air pressure reaches a preset value, the pressure switch starts the welding timer and the gun begins to seam-weld. The air motor runs continuously when the air is "on." Removing the pressure from the button control causes the solenoid valve to release the air in the cylinder. At the same time, the pressure switch cuts off both the timer and the welding current.

Since this gun has been specifically designed for welding long seams, or shorter seams on large parts, it requires a high-duty cycle and high-current densities to make its portability practical. This has necessitated provision for a large volume of water to give the proper cooling. About 5 gal. per min. are required to obtain optimum performance from the welder. The transformer, cable, jumper, and bushings are all water-cooled. The wheels are cooled internally, but spray cooling for the external parts of the wheels is available if needed.

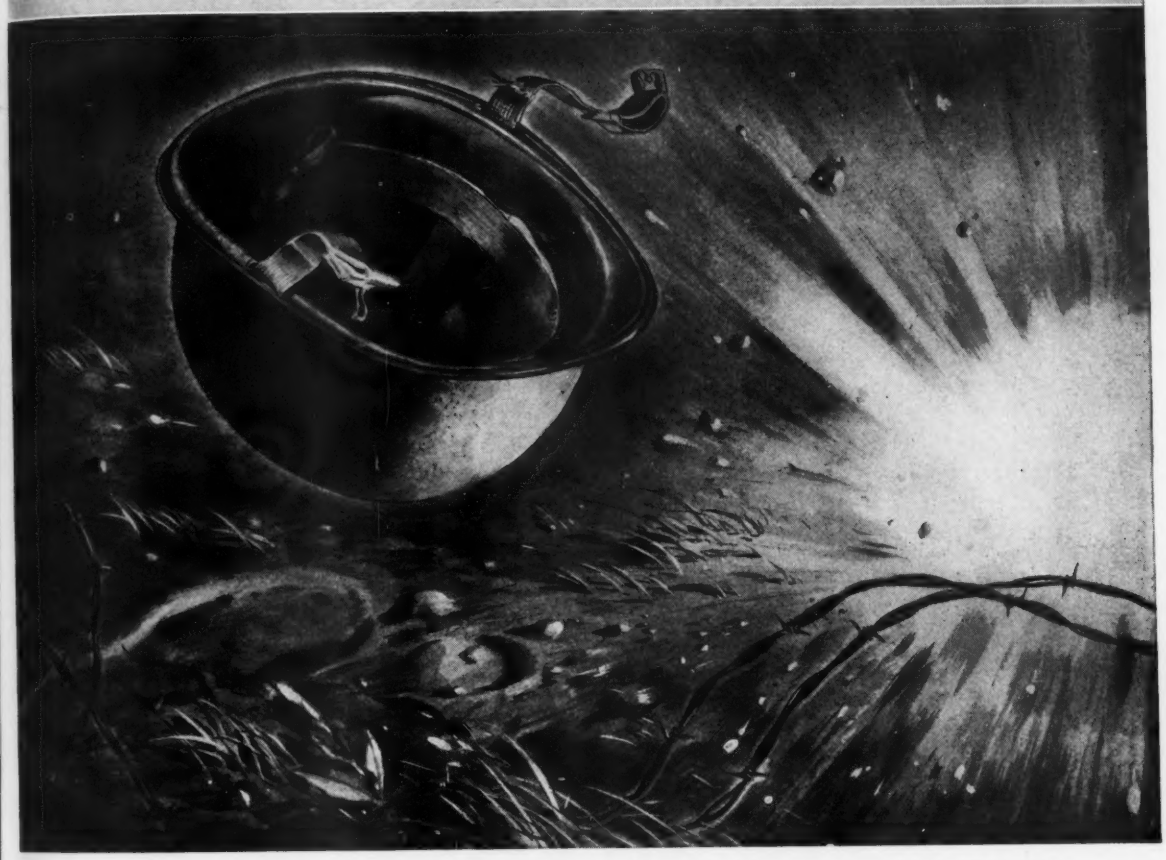
The gun has a throat depth of 3 in. Its stroke is $\frac{1}{2}$ in. when the wheels are new, and 2 in. maximum when the wheels are worn. A dial-type switch with six stages of heat selection, located on the transformer, permits accurate heat control. Standard equipment provided with this seam-welding gun includes a pressure switch, a solenoid air valve, control relay, air-line strainer, lubricator and pressure gauge, motor, air regulating valve, shut-off valve, pressure fittings for lubricating the moving parts of the gun, and an adjustable counterbalancing hangar that supports both the gun and the transformer. The transformer is rated at 100 kva., is water-cooled, and operates at 440 volts, 60 cycles. The recommended maximum duty is 2 cycles "on" (welding) and 4 cycles "off" (cooling). The cable is 750,000 cm. concentric kickless type. Progressive Welder Company, Detroit, Mich.

Anticorrosive Coating

As a result of successful tests of the anticorrosive properties of Iridite for the protection of zinc and cadmium surfaces, the Army Air Corps has discontinued its use of a finish made of chromium, which heretofore has been used for the same purpose. It is reported that The Glenn L. Martin Company, as well as other aircraft companies, following the Army Air Corps decision, is currently installing coating facilities using that material.


fedders
Heat Transfer Specialists Since 1896
HEAT EXCHANGE EQUIPMENT FOR THE AIRCRAFT AND AUTOMOTIVE INDUSTRIES
★
AIR CONDITIONING, HEATING AND REFRIGERATION EQUIPMENT
★
MACHINE GUN BELT LINKS
Heat Exchanger Division
FEDDERS MANUFACTURING COMPANY, INC., BUFFALO, N. Y.

A war can last *one minute too long...*



A man can get killed just as dead on the last day, the last hour, the last minute of the war as he can at any other time.

If American troops are delayed in their advance because we at home fail to produce the supplies they need on time, then we are guilty of prolonging the war, lengthening the casualty lists.

The great majority of American industrial workers, owners and managers realize this grim fact. They are working night and day to win the war and win it as quickly as possible. They do not want this war to last "a minute too long" for a son, brother, husband, sweetheart or friend.

The point for all of us to remember is this: Even when the newspapers tell us of new Allied victories on the fighting fronts *we must not slacken our pace on the home front.* We must do all in our power to shorten the war, to save lives.

ETHYL CORPORATION
Chrysler Building, New York City

Our war job is manufacturing Ethyl fluid for improving the antiknock quality of fighting gasolines —*and delivering it on time.* Ethyl workers have been awarded the Army-Navy "E" for "outstanding achievement in producing war equipment."

NICKEL AIDS THE POWER INDUSTRY

to KEEP 'EM OPERATING!

In this day of acute shortages of almost everything, power plant engineers are doing an amazing job of meeting demands for power—the power to keep 'em operating.

Part of this success is due to their foresight in specifying materials that assure long life and withstand the added hardships imposed by ever-increasing peak-load demands.

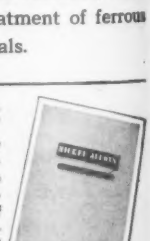
With the production of tanks, guns, and planes dependent upon power capacity, Nickel makes a valuable contribution towards uninterrupted operation, through the improved properties it imparts to ferrous and non-ferrous alloys used in power plant equipment.

So today the exigencies of war illustrate more clearly than ever the simple truth of the familiar axiom, "A little Nickel goes a long way" toward increasing the dependability of power plant equipment, from turbine blades to high pressure valves, from flange bolts to shaft forgings.

The technical staff of International Nickel has been privileged to cooperate with the power plant engineers and Government authorities who have made possible the great increases in power on which so much of the war effort depends. INCO engineers and metallurgists offer counsel and data to all who desire assistance in the selection, fabrication, and heat treatment of ferrous and non-ferrous metals.

New Catalog Index

New Catalog C makes it easy for you to get Nickel literature. It gives you capsule synopses of booklets and bulletins on a wide variety of subjects—from industrial applications to metallurgical data and working instructions. Why not send for your copy of Catalog C today?



★ Nickel ★

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N. Y.

The tests were made recently at Wright Field by the Army Air Corps with a view to determining whether Iridite would answer Army Specification AN-P-32, which calls for the finishing of zinc plate with an approved anticorrosive treatment that prevents corrosion in a salt-spray test (20 per cent at 95°F.) for 100 hours.

In the first of three tests, a steel panel, zinc plated and Iridited, was subjected to salt-spray exposure for 100 hours and then compared with an unexposed panel. No difference between the two panels was noticed. In the second test, a panel, coated with Iridite and finished with one coat of camouflage paint, was exposed on May 24, 1943, to salt spray. An inspection made on August 9 showed corrosion only on the top edge of the panel in an area covering $\frac{1}{2}$ sq.in.

The third test, which also was started last May 24, consisted of coating a panel with Iridite and subjecting it to 100 per cent humidity at 120°F. An inspection on August 9 showed a minute amount of corrosion along the four flat edges of the panel and in the string spot hole. Both tests are still going on.

According to the makers, the protective skin provided by the coating is so thin that it does not alter the dimensions of the parts to which it is applied. Since the coating is literally soaked into the metal, it is not impaired by bending, forming, or twisting. Under ordinary conditions, 100 gal. of the solution will coat 20,000 sq.ft. of work. Plated parts are treated by dipping them in a proper solution of the chemical for from 10 to 60 sec. A hot water rinse is recommended to facilitate drying. Rheem Research Products, Inc., Baltimore, Md.

Gear Tester

A gear tester has been developed for the inspection of precision gears. It is designed for the purpose of detecting and locating faults during the manufacturing process and to check the accuracy of completed gears. The instrument is of vertical construction, occupies little bench space and is readily transported. The master gear—or gear known to be correct—is placed on an arbor, and the gear to be tested is placed on another arbor directly in contact with the master gear. The master gear bracket is provided with a counterbalance that can be adjusted so that the pressure between master gear and gear to be tested is always uniform.

Beneath the gear under inspection is a handle with a pinion, which the operator uses to rotate the gears. Any divergence or error is shown in the comparator head which reads to 0.001, 0.005, 0.0025, or 0.0001 in. as desired, depending upon the class of work and the precision required. It is stated the tester will show up rolling action between two working gears or gear and pinion; the eccentricity of gears, if any is present; and any variation in gear tooth thickness. George Scheer Company, New York.

Square D type B2A 25-amp. aircraft contactor.

Automatic Engine Control

A more advanced model of the Simmonds-Hobson automatic engine control, known as the Mark 46, is now in quantity production. Like its predecessor models, the current unit is designed as an adjunct to supercharged aircraft engines for the purpose of relieving the pilot of manually operating certain cockpit controls and to provide engine protection through preventing damage as a result of excess manifold pressure (over-boost).

The makers state that the new model automatically selects mixture strength, as well as manifold pressure, and provides selected settings of the throttle control level at "Take-Off," "Rated," and "Economical Cruising Boost" positions, employing the same basic principles of operation as the earlier Mark 40 "boost" control. The principal part of the Mark 46 is the evacuated aneroid, or capsule, an extremely sensitive device which, responding to changes in manifold pressure, moves a servo piston by means of an oil slide valve which in turn actuates the carburetor throttle control. With the device the pilot is relieved of the need of adjusting mixture control to give lean mixtures in the cruising range, and adequately rich mixtures are provided if he must suddenly open his throttle from the cruising to the high-power range. Simmonds Aerocessories, Inc., New York.

25-Ampere Aircraft Contactor

A 25-amp. Type B2A aircraft contactor is manufactured to meet Army Air Forces' specification No. 94-32185D. It is now available in the Class 9350 aircraft contactor line, which previously included 50-, 100-, and 200-amp. sizes. These B2A contactors may be used for remote control, starting and stopping of d.c. motors, or as relays in gun-fire, lighting, or communication circuits.

Class 9350 Type B2A contactors weigh only 7 oz. and are rated 25 amp. continuous duty for potentials up to 29 volts d.c. The contactors are designed to operate successfully under acceleration forces up to 10G or vibration conditions as severe as 55 cycles per sec. at $\frac{1}{16}$-in. excursion. They are suitable for operation through a temperature range of −65° to +160°F. and are not damaged when exposed to temperatures of −75° to +200°F. Square D Company, Milwaukee, Wis.

Hydraulic Jack for Airplane Service Work

The new Simplex No. 7400 hydraulic wing jack has a 10-ton hydraulic center-column lifting unit for fast lifting and is equipped with a safety retainer collar to carry compression loading and give positive load locking. Other features claimed by the maker are a spherical hydraulic base seat to prevent eccentric loading of the hydraulic jack unit and screw adjustment to allow for micrometric leveling of airplanes for instrument checking.

The addition to the Simplex line of airplane jacks has the same nonrocking tripod and construction of its companion models. Its specifications are: minimum height, $43\frac{1}{4}$ in.; hydraulic lift, 24 in.; screw lift, $7\frac{1}{4}$ in.; maximum height, $74\frac{3}{4}$ in.; and weight, 265 lbs. Templeton, Kenly & Company, Chicago, Ill.

Synthetic Rubber Seals Underground Aviation-Fuel Tanks

Designed to help offset a shortage of steel plate for purposes where no substitute is available, large underground concrete fuel-storage tanks have recently been installed by the U.S. Navy on the mainland and at strategic overseas bases. Construction of the tanks was expedited through the use of Thiokol synthetic rubber.

Early in 1940, the Navy's Bureau of Yards and Docks, foreseeing a shortage of steel plate, began to investigate the practicability of using concrete storage tanks to meet the increased demand for fuel-storage facilities. While the heavy fuels presented no problem, light fuels, such as Diesel oil and aviation gasoline, tended to seep through the pores of the concrete. High-octane gasoline, moreover, suffered a serious drop in octane rating and formed a sticky gum when exposed to the alkaline present in the concrete. Research resulted in the development of a lining which, when applied to the concrete sidewalls, floors and columns of the tank, not only protected the octane rating of the gasoline but formed a container which remained leakproof even when the concrete wall cracked due to stresses, ground shifts, or temperature changes.

Known as Thiokol *FA*, the material is reported to have been the first commercially successful synthetic rubber produced in this country. It has long been used in the fabrication of hose and other solvent-resistant specialty products.

Applying the lining resembles the hanging of wallpaper. After all surface irregularities have been removed, the

They wanted a perfect stud

—*turned out by the millions*
—*accurate to ten-thousandths*

THE studs used in one of America's most famous high-efficiency radial engines must be as nearly flawless as man can make them. Millions were needed—and in a hurry.

Manufacturers found the answer in *pretempered* Amercut Cold Finished Steel Bars. Why? Because pretempering, as developed by American Steel & Wire engineers, provides in bar stock the *identical* physical properties that are required in the finished product.

By eliminating heat treatment of parts after fabricating, pretempering makes re-straightening, grinding, cleaning and re-dressing of threads unnecessary. It's a time and cost saver. It minimizes rejections.

Used in radial engine studs and similar parts, pretempered Amercut Bars really pay off. They speed up output, promote dimensional stability and insure the maintenance of high physical standards. They can be used with equally good results on other applications in which similar high requirements must be met.

Listed below are other airplane materials that have found their place in America's finest planes. Tireless check and scrutiny safeguard their quality and insure their fine performance in service. Our mills have the facilities to produce them in large quantities.

THESE AIRPLANE MATERIALS HAVE EARNED THEIR WINGS:

AIRCRAFT QUALITY WIRE
Every type, including stitching wire, hinge-pin wire, strut and tie wire, lock wire, cotter-pin wire, special shape wire. Supplied in carbon, alloy and stainless steels. Bright, tinned or galvanized finishes.

AIRCRAFT CONTROL AND STRUCTURAL CABLES
Assemblies and fittings.

COLD FINISHED BARS
Standard analyses in round, square and hexagon shapes.

COLD ROLLED STRIP STEEL
Stainless, carbon and alloy in widths up to 24 inches.

SPRINGS
Extension, Compression, Torsion, Flat Spiral or Motor types.

WIRE FORMS
Special formations and sizes.

WELDING ROD
Bare—carbon, alloy and stainless.

AIRCRAFT SPECIAL NAILS AND PINS

USS

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Export Company, New York

UNITED STATES STEEL

tank walls are coated with a special synthetic rubber cement, developed by the Boston Woven Hose Company. When this has thoroughly dried and a second coat of the adhesive has reached the right stage of tackiness, strips of Thiokol are hung on the walls, columns, and floors so that every square inch of bare concrete is covered. In addition to being completely indistinguishable from the air, these concrete tanks are claimed to be practically invulnerable to fire from normal operational hazards. Thiokol Corporation, Trenton, N.J.

Junction Box Set

Immediate delivery can now be made of cord sets with junction box assemblies for interphone communication equipment. This unit consists of a length of special, two-conductor, tinsel cordage with a two-conductor plug attached to the cordage on one end and a junction box attached on the other end. The JB-47 junction box has a two-piece Bakelite plastic case. The lower section of the case has two silver-plated, copper terminal jumpers, and four terminal binding posts for the necessary connections.

Rigid cord clamps are molded into both sections of the case to hold the cordage firmly in place and prevent slipping. A tight-fitting Neoprene jacket sleeve makes a close seal over the end of the PL-55 plug, which is connected to the cordage. The complete cord set, or any integral part, can be furnished. Trav-Ler Manufacturing Radio & Television Corporation, Chicago, Ill.

Welding Arc Stabilizer

To speed the electric arc welding of the delicate aluminum and alloy steel parts used in aircraft construction, a device has been developed called an arc stabilizer. The device consists of an assembly of coils, condensers, and transformers that is incorporated into an electric welding machine. Part of the stabilizer is a spark-gap oscillator. The stabilizer produces high-voltage alternating current which is used to ionize the air between the tip of the welding rod and the metal being welded. The device is intended to counteract the tendency of the welding arc to break each time the welding current alternates. Westinghouse Electric & Manufacturing Company.

"Rivet Robot"

A device for the elimination of uneven riveting has been developed by Willys-Overland. Called a "rivet robot," this device is said to be a means of enabling unskilled workers to double their production.

The robot can be attached to any standard riveting gun and used to control automatically the number of blows applied to rivets. By regulating the gun, it is reported to be possible to obtain uniformity in the production of riveted aluminum aircraft sections, thus eliminating "stress areas" that generally result in faulty construction. Since the burden of control of the riveting gun is placed on the device itself, the possibility of error on the part of the unskilled worker or student is reduced.

Basically, the robot works like the time exposure on a camera. It consists of a cylinder, spring, and piston that automatically control the number of strokes made by the rivet gun in accordance with the size of the rivets used. By the application of its basic principle of operation the new device can be adapted to control any liquid, gas, or air flow on any mechanical tool or instruments. Willys-Overland Motors, Inc., Toledo, O.

Oil Purifiers

Lubricating and hydraulic-oil reclaimers, made in capacities ranging from 2½ to 120 gal. in 70 to 90 min., are recommended by the makers for restoring all types of used oils, including oils drained from aircraft engines, hydraulic machines, gear reducers, compressors, portable engines, and similar installations.

There are eleven different models in two series designed as the A and AH lines—both types using contact filtration in which common refinery earths available on the open market are utilized. The machines have a two-stage filter press, are semiautomatic (operating under thermostatic control), and permit the operator of the machine to attend it in addition to his regular work. The machines are said to be capable of reclaiming used oils without presettling or pretreatment and of restoring the oil to substantially the same values of fire, flash, viscosity, color, neutralization number, and precipitation number as the new parent oil. The maker also builds large machines for special requirements.

A portable unit, mounted on a trailer, includes a standard type Y-M reclaimer, a Diesel-electric generating set, clean oil storage tank, fuel-oil tank, and waterproof storage bins for refinery earths, filter papers, and squares.

In operation, a charging pump conveys the dirty oil from drums on the ground to the heating tank, where it is brought to a sufficient temperature in contact with refinery earth to dissipate the volatiles. The heating process is controlled by thermostats. When the proper temperature is reached, the oil is dropped into a transfer tank and then forced through a two-stage filter by compressed air and out to the clean-oil receiving drums. Youngstown Miller Company, Sandusky, O.

(*Continued from page 31*)

If the web is a membrane, $r = 0$, and Eq. (7) reduces to

$$\cot \alpha \sqrt[4]{\lambda + 1} \qquad (8)$$

The general expression for λ is as follows:

$$\lambda = btE_w \left[\frac{b^3}{720hE_f}\left(\frac{1}{I_{fc}} + \frac{1}{I_{ft}}\right) + \frac{1}{E_s A_s}\right] \qquad (9)$$

If the moduli of elasticity of the web flanges, and the stiffener are equal and the moments of inertia of the beam compression and tension flanges are equal, Eq. (9) reduces to the following:

$$\lambda = bt\left(\frac{b^3}{360hI_f} + \frac{1}{A_s}\right) \qquad (10)$$

where

I_f = the moment of inertia of a beam flange about its neutral axis
A_s = cross-section area of a web stiffener
b = the web stiffener spacing
h and t have the same significance as stated above.

The net load carried by the flange rivets in one bay is determined by the equation:

$$P_r = bt\sqrt{T^2 + (T \tan \alpha - T_{cr})^2} \qquad (11)$$

where the symbols have the significance stated above.

The method of plate girder web analysis outlined in Eqs. (5) through (11) gives the same accuracy in the conventional design range as the earlier method but is also equally accurate when checked against full-scale beam tests for arrangements of the web system outside the usual range. It is also easier to apply when a chart has been plotted for the purposes of determining the angle α. In the use of this method, the strength of the web system in shear should be taken from Eqs. (5) or (6) whichever is the smaller.

Conclusion

The various technical advances discussed herein represent the conclusion of major projects. Other equally important work is still in progress. Such subjects as heat anti-icing and its related functions, improved drafting techniques, loft reproduction processes, improved methods of stress analysis, methods of cabin supercharging, and structural value of certain rivets are some of the projects now in work. So long as American aircraft engage the enemy or compete with one another Consolidated Vultee will exert every effort to produce a more than adequate product in the shortest possible time.

Reference

[1] Giffen, Harvey D., *The Vultee Radio Recorder*, Aeronautical Engineering Review, Vol. 2, No. 7, p. 9, July, 1943.

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means
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Institute News

Twelfth Annual Meeting

The Twelfth Annual Meeting of the Institute will be held January 25, 26, and 27 in the Pupin Physics Laboratories of Columbia University. To facilitate attendance at technical sessions, meetings will be held only during the afternoon and evening of each day.

The technical sessions will be preceded by the Honors Night Dinner of the Institute at the Hotel Waldorf-Astoria, New York, Monday evening, January 24, 1944.

Gifts to the Aeronautical Archives

The collections of source materials in the Aeronautical Archives increased notably during the month. Col. Stedman Shumway Hanks gave ten volumes of scrapbooks dealing with the development of "Flight Strips" from 1935 to 1943, covering the work of planning commissions, societies, and Government agencies in the development of auxiliary ground facilities for aircraft adjacent to highways. The collection is especially important because of Colonel Hanks' connection with the program from its beginning.

The Glenn L. Martin Company gave a large scrapbook dealing with the activities of Glenn L. Martin from February 4, 1910, to October 7, 1928, forming an important source for the history of American aeronautics during that period.

A collection of books, clippings, and documents was received from A. Roy Knabenshue, in addition to those received previously. Among the source materials in this collection are 32 letters concerning Mr. Knabenshue's negotiations on dirigibles with the U.S. Navy Department in 1914, 1915, and 1916, including several letters signed by Josephus Daniels and Franklin D. Roosevelt as officials of that Department.

Through Fred C. Kelly, Miss Imo L. Reece, of Bucyrus, O., gave a large photograph of Wilbur and Orville Wright and Walter Brookins, taken in Indianapolis in 1910. This photograph, one of the few showing the Wright brothers together, was taken by a photographer under instructions from Dr. M. M. Henry, at that time a resident of Dayton, O., after whose death it was sent to the Aeronautical Archives for preservation.

Dr. Alexander Klemin added a number of books and pamphlets on technical subjects to previous gifts and gave more than 150 clippings dealing with Amelia Earhart, Charles A. Lindbergh, and the National Air Races.

The British Air Commission sent additional R.T.P. Translations for the large collection previously given. Harry Zuckerberg gave 39 of these Translations which had not previously been in the collection and several duplicates.

E. J. Foley gave several hundred clippings dealing with the history of the Atlantic Division of the Pan American Airways System from the early spring of 1939, when transatlantic service was begun, to the spring of 1943, and offered his services in organizing them.

Mrs. Bella C. Landauer added prints and sheet music to the large collections previously given. More than 700 numbers of periodicals were given by the Eclipse-Pioneer Division of Bendix Aviation Corporation, and 350 numbers of periodicals were received from the University Club Library. L. J. Odone and the Mack Printing Company gave several books to add to previous gifts. The Northern Pump Company, through John B. Hawley, Jr., gave ten marine prints. Charles Hubbel gave 57 aeronautical prints which he made for Thompson Products, Inc.

The Army Air Corps gave a number of plastic models of airplanes. The collections of aeronautical insignia continued to expand. Among those received was a wing insigne of the Chinese Air Force, from Major Gen. P. H. Whang. A special inlaid wooden placque with insignia of Pratt & Whitney Aircraft Division of United Aircraft Corporation was added to the collection through the generosity of that company.

New Corporate Member

Electrol Incorporated, Kingston, N.Y., has recently become a Corporate Member of the Institute. The company's Hydraulics Division was organized in 1940 and spent its first year almost entirely in designing hydraulic equipment for military aircraft.

Among the developments of the company which have been in production for the past two years are pressure relief valves, hand pumps, shuttle valves, thermal relief valves, selector valves and, particularly, unloading valves in capacities of 5, 16, and 29 gal.

Equipment of Electrol design is used on the Grumman Avenger, Wildcat, and Widgeon; the Republic Thunderbolt; the Brewster Buffalo; and others.

Sections and Branches

Akron Section

At the first meeting of the current year, held on September 7, the following officers were elected: Chairman, C. J. Peirce, of Goodyear Aircraft Corporation; Vice-Chairman, R. D. Spencer, of the General Tire & Rubber Company; Secretary-Treasurer, T. H. Troller, of the Guggenheim Institute; Program Committee Chairman, P. O. Huss, of the Guggenheim Institute.

At the first technical meeting on September 21, V. S. Kupelian of the Goodyear Aircraft Corporation spoke on "Flight Test Procedure."

Detroit Section

A dinner meeting was held on September 15 at the Horace H. Rackham Educational Memorial. Charles R. Beltz, Cycleweld Engineer of the Chrysler Corporation, gave a talk on the possibilities of the process in aircraft construction. The lecture was illustrated by slides and samples.

San Diego Section

At a meeting on September 10 a paper on "Newest Developments in Aeronautical Meteorology" was presented by Maurice A. Garbell of the Development Engineering Group of Consolidated Vultee. After reviewing briefly the history and techniques of aeronautical meteorology, Dr. Garbell discussed the important part that aeronautical meteorology has had in all of the strategic and tactical operations of global warfare, with particular emphasis on the theory and practice of long-range forecasting, "detail forecasting," and the recent science of tropical forecasting which has had an important bearing on the warfare in the South Pacific and in other military operations. The talk was followed by three U.S. Army training films.

On October 1 a business meeting was held at which the past year's record was reviewed and plans for the coming year were laid. Nominations were made for officers who will be elected by mail ballots. A motion picture was shown on the recognition of the Japanese Zero and the film *Hell's Angels* also was exhibited.

Aeronautical University, Inc.

At a business meeting on September 28, officers for the new term were elected

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3. Inherently high heat conductivity with consequent wider range between pre-ignition and fouling.
4. Absolute uniformity of material.
5. Homogeneous structure eliminates air spaces which cause current leakage.
6. Easily cleaned and serviced—no specialized equipment or factory returns necessary.
7. Scientifically controlled manufacture.

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as follows: Louis F. Beller, Chairman; George G. Graham, Vice-Chairman; and Gus S. Papas, Secretary-Treasurer.

After a discussion of the disposition of funds in the treasury for the next term, it was unanimously decided to invest at least 80 per cent of the money in United States War Bonds. A committee of four was appointed to manage the induction of new members.

Alabama Polytechnic Institute

At meetings on September 13 and 27 the films *Construction of the Consolidated PBY Catalina* and *Messerschmitt Fighter* were exhibited.

Casey Jones School of Aeronautics

The semiannual "Dog Day" was held on October 4. On this occasion 30 new members were admitted to the Branch.

The Catholic University of America

New officers for the coming year were elected at a meeting on September 9. They are as follows: President, John J. Gardner; Secretary, Donald A. Gardner, Jr.; and Treasurer, Luke Liccini.

Georgia School of Technology

At recent meetings the principal part of the program has been devoted to the showing of industrial and educational films. Among these were *The History of Aircraft* and *Streamlined*. Because the former secretary of the Branch has left the school, J. B. Gattey has been elected as Secretary.

The Georgia Tech. Student Branch is planning to erect a placque as a memorial to Montgomery Knight, who had been Professor of Aeronautical Engineering and Director of the Daniel Guggenheim School of Aeronautics since 1930.

Indiana Technical College

Following the close of the summer term, a banquet was held at which the guest speaker was Robert Schott, Manager of the Fort Wayne Municipal Airport. He spoke on the importance of a well-designed airport and on the future of aviation.

New officers were elected as follows: Chairman, Ralph Wilcox; Vice-Chairman, Clyde Heaton; Secretary, Bob Rawlinson, Treasurer, Waldo Schock. Prof. Waldo Albert will continue as Honorary Chairman.

University of Notre Dame

Nominations for officers were made at a meeting held on October 8. Activities during the summer were limited to social and athletic events.

University of Oklahoma

The film *Aerodynamics* was exhibited at a meeting held September 23. A business session followed the showing of the film.

Spartan School of Aeronautics

At the meeting on September 9 the student speaker was Oran Nicks who lectured on the "History of the Development of the Allison Engine." Following the talk a business session was held and new officers were elected as follows: Chairman, Oran Nicks; Vice-Chairman, Carl V. Lindow; Secretary-Treasurer, Donald W. Benson; Program Chairman, Adrian Henneberger.

University of Texas

Two motion pictures, *Building a Bomber*, which covers the construction of the Martin B-26, and *Hamilton Hydromatic Propellers* were shown at a meeting on September 8.

News of I.A.S. Members

Hugh E. Allen, formerly Aviation Radio Engineer with the RCA Manufacturing Company, has been commissioned a Lieutenant Commander in the U.S. Naval Reserve and assigned to the Engineering Division of the Bureau of Aeronautics.

Cecil W. Armstrong was recently appointed Chief Engineer of Marco Chemicals, Inc.

Matthew L. Blakely has been commissioned a Second Lieutenant in the U.S. Marine Corps Reserve and assigned to active duty.

Carlos R. Chang is now studying navigation instruments at the Sperry Gyroscope Aeronautical School.

George G. Cudhea was advanced to the position of Assistant Chief Engineer at Fleetwings.

Jules E. DeCrescenzo has entered the Government service as Senior Maintenance Supervisor in the War Training Service.

Frederick J. Doering, Jr., has been appointed Associate Aeronautical Engineer in the Structures Unit of the Aircraft Engineering Branch of the Civil Aeronautics Administration.

James R. Downey received his commission as an Ensign in the U.S. Naval Reserve and was assigned to the Bureau of Aeronautics.

Stanley H. Evans, formerly Director of Engineering at the Ryan School of Aeronautics, has been appointed Principal Technical Officer in the Technical Investigations Branch of the British Air Commission, at Washington, D.C.

Justin A. Fitz, who has been with the Sperry Gyroscope Company for 26 years, recently as Public Relations Manager, was promoted to Advertising Director.

Nicholas F. Greener has been made Administrative Assistant in the Defense Supply Corporation.

James J. Gruff, formerly Stress Analyst with Meyers Aircraft Company, has been commissioned an Ensign in the U.S. Naval Reserve.

Paul E. Hovgard, who has been Chief Research Engineer with The Glenn L. Martin Company, has rejoined Curtiss-Wright Corporation, with which he was connected prior to 1926. He has become Assistant to the Director of Engineering at the Buffalo plant of the Curtiss-Wright Airplane Division.

Franklin H. Joseph, formerly in the sales division of Sperry Gyroscope has been commissioned a First Lieutenant in the Army Air Forces.

Leonard W. Klauer, Structures Engineer with Curtiss-Wright, has received his Ensign commission in the U.S. Naval Reserve.

Marck B. Komorn recently joined Plastics Moulding Corporation as Chief Engineer.

Charles E. Kroupa is now a Second Lieutenant in the U.S. Army Air Forces.

Arnold M. Kuethe, formerly Associate Professor in the Department of Aeronautical Engineering at the University of Michigan, has been advanced to the rank of Professor.

Emil A. Lehecka entered the service of the Board of Education of New York City as an Instructor in Aviation Mechanics.

Hoshen Lu is now Senior Aerodynamicist at the Republic Aviation Corporation.

Jerome B. Meyer has joined Aeronca Aircraft Corporation as Structures Engineer.

Donald E. Platz entered the Technical Training Command of the U.S. Army Air Forces.

Conrad H. Poppenhusen is now a Tool and Die Engineer with North American Aviation.

Leonid Samuel is a Junior Engineer at the Engineering & Research Corporation.

Lt. James H. Smith, Jr., formerly Assistant Manager of the Atlantic Division of Pan American Airways System, has become a Flight Officer in a Carrier Squadron of the U.S. Navy.

Basil Staros was commissioned an Ensign in the U.S. Navy.

William G. Street is an Engineer in the Flight Research Department of Consolidated Vultee Aircraft Corporation.

Nathan F. Vanderlipp has been advanced to the position of Factory Manager in the Columbus Plant of Curtiss-Wright Corporation.

Louis J. Weber has joined Van Tuyl Engineering, Inc., as Stress Engineer.

Raymond R. Wiese has been promoted to Administrative Engineer at Fleetwings.

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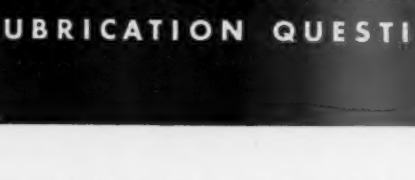

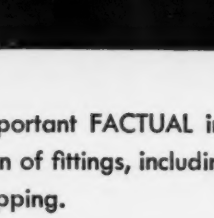

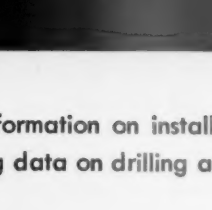

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Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Duncan, Ian Gair, Special Appointment, Ministry of Aircraft Production, England.

Kartveli, Alexander, Vice-Pres. and Chief Engineer, Republic Aviation Corp.

Elected to MEMBER Grade

Adamson, Roy G., B.S. in M.E.; Aero. Design, Hoosier Aircraft Co.

Anderson, Franklin Charles, B.S. in Ae.E.; Stress Analyst, Bell Aircraft Co.

Baughman, George W., B.S. in Ae.E.; Project Engineer, Cessna Aircraft Co.

Bender, Donald C., B.S. in M.E.; Test Engineer, Hayes Industries, Inc.

Bird, Walter Wallace, S.B. in Ae.E.; Structures Unit Head, Airplane Div., Curtiss-Wright Corp.

Boggess, Harry Edward, Lt. Comdr., U.S. Navy, Supt. of Aviation Training.

Bryan, Colgan Hobson, M.A.; Acting Head of Dept. of Aero. Engineering, Univ. of Alabama.

Cadambe, V., M.S. in Ae.; Stress Analyst, Hughes Aircraft Co.

Campbell, Byron Frederick, B.S. in E.E.; Chief of Laboratories, The Glenn L. Martin Co.

Chapleo, Charles, Chief of Technical Dept., Airspeed (1934) Ltd., England.

Clingman, George J., Principal Maintenance Supervisor, Dept. of Commerce, C.A.A.

Cogswell, Stewart Wellesley, Instructor in Aeronautics, Volusia County Defense Training School.

Cumming, John Sheppard, Lt., Air Engineer Officer, Admiralty, Royal Navy.

Daly, Henry Lincoln, B.S. in Ae.E.; Chief Weight Engineer, Columbia Aircraft Corp.

Eaton, Edwin Darby, B.S. in E.E.; Administrative Engineer, Hamilton Standard Propellers Div., United Aircraft Corp.

Emery, Elliott Gifford, Jr., B.S. in G.E.; Field Rep., Pesco Products Co.

Foley, Edward Joseph, B.Ae.E.; Asst. to Vice-Pres., Engineering, American Airlines, Inc.

Goodman, George Parker, B.S. in Ae.E.; Structures Engineer, Columbia Aircraft Corp.

Halpern, Herman, M.E.; Aerodynamicist, Chance Vought Aircraft Div., United Aircraft Corp.

Horn, William H., B.S. in Ae.E.; Project Engineer, Stout Research Div., Consolidated Vultee Aircraft Corp.

Lewis, Patton, B.Sc. in M.E.; Leader, Engineering Section, Lockheed Overseas Corp.

Loomis, William Fitch, B.A.; Sales Engineer, Pratt & Whitney Aircraft Div., United Aircraft Corp.

Marhoefer, Laurence Joseph, B.S. in C.E.; Vice-Pres., Engineering, Vidal Research Corp.

Merandi, Louis P., B.Ae.E.; Design and Mfr. of Aircraft Parts, Hughes Aircraft Co.

Miller, Charles Hart, Ae.E.; Vice-Pres. and Divisional Mgr., Republic Aviation Corp.

Moore, Vincent, M.S.; Asst. Project Engineer, Wright Aeronautical Corp.

Perier, Claude Henry, M.A. in Chem.; Supervisor, Bendix Aviation Ltd.

Polivka, Jaro Joseph, M.S., D.E.; Research Assoc., Dept. of Civil Engineering, Univ. of California.

Poupitch, O. Jules, B.S. in C.E.; Director of Research, Illinois Tool Works, subsidiary of Shakeproof Inc.

Readey, John M., Production Coordinator of Experimental Airplanes, Bell Aircraft Corp.

Rosenberg, Albert Joseph, B.S. in Ae.E.; Chief, Special Services Section, Airlines War Training Institute.

Sporleder, Ernest Bassett, B.S. in Ae.E.; Executive Engineer, Douglas Aircraft Co., Inc.

Stellman, Louis Marlon, B.S. in M.E.; Asst. Shop Supt., Naval Aircraft Factory.

Stevenson, David Blaine, B.Ae.E.; Assoc. Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Stupar, Max, Chief of Industrial Planning, Bell Aircraft Corp.

Towle, Tom, M.E.; Chief Engineer Hudson Motor Car Co.

von Plonski, Herman John, B.S. in Ind.E.; Factory Supt., McDonnell Aircraft Corp.

Warren, Edwin Averell, B.S. in M.E.; Contract Manager, Curtiss-Wright Corp.

Welling, Omer, Chief, Flight Analysis Section, C.A.A.

Wise, Karl Marshall, B.S. in M.E.; Director of Engineering, Bendix Products Div., Bendix Aviation Corp.

Woodson, Omer Lee, Vice-Pres. and Mgr., Bell Aircraft Corp.

Yerkes, Harry Wardle, Jr., Quality Engineer, Aeronca Aircraft Corp.

Transferred to MEMBER Grade

Cote, Oliver H., Jr., B.Ae.E.; Lt. Comdr., U.S.N.R., Head of Structural Modifications Section, Bureau of Aeronautics.

Hoffer, Jerome, M.S. in Ae.E.; Sr. Aerodynamicist, Brewster Aeronautical Corp.

Michel, Philip Lincoln, M.A.E.; Chief Aerodynamicist, Brewster Aeronautical Corp.

Sandowski, Wladyslaw, M.S. in Ae.E.; Asst. Chief Engineer, Equi-Flow, Inc.

Elected to Industrial Member Grade

Ayres, Waldemar A., A.B.; Asst. to Vice-Pres. for Engineering, Sperry Gyroscope Co., Inc.

Braniff, Thomas Elmer, President, Braniff Airways, Inc.

Hirsch, Frederick S., B.C.S.; Head of Aviation Securities Dept., Hirsch, Lilienthal & Co.

Kilgen, Eugene Robyn, President, Aircraft Div., The Kilgen Organ Co.

Lehman, Robert, A.B.; Partner, Lehman Bros.

MacKinnon, John Charles, Sales Engineer-Aircraft, Hood Rubber Co. Div., B. F. Goodrich Co.

Mallach, Joseph William, Director of Production Engineering, Ranger Aircraft Engines Div., Fairchild Engine & Airplane Corp.

Mosier, Orval Mck., Vice-Pres., American Airlines, Inc.

Mueller, Rudolf Carl, Partner, Omaha Aircraft Co., Scientific Radio Products.

Ogsbury, James Stanley, Pres., Fairchild Aviation Corp.

Redfern, Merrill Frank, A.B.; Secretary, Air Transport Association of America.

Roberts, George Clements, Secretary, Illinois Aeronautics Commission.

Shuping, Warren A., Chief Inspector, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Taylor, Irving Henry, Eastern Rep., Douglas Aircraft Co., Inc.

Wilson, Raymond Milton, B.S. in E.E.; Partner and Mgr., Wilson-Bonfils Flying School.

Zacharias, David Leroy, Treas. and Sect., Taylorcraft Aviation Corp.

Elected to Technical Member Grade

Bissell, Herbert, Experimental Contact Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Bolin, Norton S., Lt., U.S. Army Air Forces.

Booth, Jean, B.A.; Research Asst., R. W. Cramer, Co. Inc.

David, Lyn, Group Leader, Simmonds Aerocessories, Inc.

Davis, Charles M., Jr., B.S. in M.E.; Asst. Engineer, Ames Aero. Lab., N.A.C.A.

Gross, Jerome A., LL.B.; Airplane Stress Analyst, Airplane Div., Curtiss-Wright Corp.

Hanslip, Richard E., B.S. in M.E.; Detail Stress Engineer, Fisher Body Detroit Div., Central Engineering Dept., General Motors Corp.

Hicks, Earl J., B.S. in M.E.; Jr. Engineer, Airplane Div., Curtiss-Wright Corp.

Holden, William Varley, R.C.A.F.

Kennedy, Charles C., B.S. in Ae.E.; Research Engineer, Airplane Div., Curtiss-Wright Corp.

Lord, Leland Hume, B.S. in Ae.E.; Jr. Layout Draftsman, Vega Aircraft Corp.

Louis, Harry, M.E.; Project Engineer, Canadian Pacific Air Lines Ltd., Canada.

Lubinsky, Allan L., B.S. in Ae.E.; Jr. Weight Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Murphy, Henry Thayer, B.S. in Ae.E.; Design Engineer, Boeing Aircraft Co.

Neffson, Ben Arnold, B.C.E.; Stress Engineer, Salvage Engineer, Allentown Div., Consolidated Vultee Aircraft Corp.

Nordin, Clarence Waldemar, B.S. in C.E.; Preliminary Design, Boeing Aircraft Co.

O'Keefe, Charles J., Jr., B.A.E.; Aerodynamicist, Grumman Aircraft Engineering Corp.

Peilen, Ellis, B.Ae.E.; Instructor, Univ. of Minnesota.

Petri, Henry Law, Service Engineer, United-Carr Fastener Corp.

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Reid, David Gene, M.F.; Research Engineer, Universal Moulded Products Corp.

Rossall, Chauncey Newkirk, A.E.; Development Engineer, Goodyear Aircraft Corp.

Scheer, Richard D., B.S. in AeE.; Aircraft Sales Engineer, Plastics Dept., E. I. du Pont de Nemours & Co., Inc.

Seibel, Charles M., M.S. in Ae.E.; Research Engineer, Bell Aircraft Co.

Sliney, Ralph E., Jr., B.A.E.; Aerodynamicist, Grumman Aircraft Engineering Corp.

Stickel, Edward Leonard, Aviation Cadet, U.S. Army Air Forces.

Truit, Robert Wesley, A.B. in Physics, Instructor in Aero. Engineering, North Carolina State College.

Tseu, Payson Sung, B.S.; Jr. Stress Analyst, The Glenn L. Martin Co.

Underberg, Samuel, 1st Lt., Corps of Engineers, N.Y. State Guard; Engineer, Fairchild Aircraft Div., Fairchild Engine & Airplane Corp.

Yorgiadis, Alexander John, M.Sc.E.; Research Engineer, Sonntag Scientific Corp.

Transferred from Student to Technical Member Grade

Aller, Paul Brown, B.S. in M.E.; Jr. Aero. Engineer, Naval Aircraft Factory.

Bezark, Richard S., B.S.

Brown, St. George Ambler, B.S. in Ae.E.; Lt., U.S. Army Air Forces.

Buterbaugh, Floyd Forest, Design Engineer, Naval Aircraft Factory.

Carnwath, James Robert, B.S. in Ae.E.; Liaison Engineer, Boeing Aircraft of Canada Ltd.

Foster, Berry Wilmot, M.A.; Stress Analysis Engineer, Airplane Div., Curtiss-Wright Corp.

Graham, Frank Dunstan, B.S.E.; Aero. Engineer, Fleetwings Div., Kaiser Cargo Inc.

Hinder, Leonard Samuel, B.Ae.E.; Jr. Research Engineer, Republic Aviation Corp.

Keuper, Robert Francis, B.Ae.E.; Jr. Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Lach, Charles Peter, Private, U.S. Army.

Markosian, Sylvan, Draftsman, Chance Vought Aircraft Div., United Aircraft Corp.

Newark, John Taylor, B.S. in Ae.E.

Reif, Herman, B.S. in Ae.E.; Project Liaison, Boeing Aircraft Co.

Robinson, Robert Cole, B.Ae.E.; Jr. Engineer, Ames Aero, Lab., N.A.C.A.

Schleck, Herman Anton John, Detail Designer, Eastern Aircraft Div., General Motors Corp.

Zeiller, Ernest Lewis, B.S. in Ae.E.; Jr. Aero. Engineer, Ames Aero. Lab., N.A.C.A.

Elected to Affiliate Grade

Horner, Maurice L., Jr., Ph.B.; Lt. Comdr., U.S. Navy.

Michaelson, Helen G., A.B.; Asst. to Mgr. of AERONAUTICAL ENGINEERING REVIEW, Institute of the Aeronautical Sciences, Inc.

Sullivan, William Ambrose, Rev., M.S.; Assoc. Prof., Dept. of Physics, Providence College.

Wright Brothers Lecture

U. S. Chamber of Commerce Auditorium

Washington, D.C. **December 17, 1943**

The Seventh Wright Brothers Lecture of the Institute will be presented by W. S. Farren, Chief Superintendent of the Royal Aircraft Establishment, England. Mr. Farren will speak on:

"Research for Aeronautics, Its Planning and Application"

This year will commemorate the Fortieth Anniversary of the flight of the Wright Brothers at Kitty Hawk, N.C., on December 17, 1903. The U. S. Chamber of Commerce Auditorium has been made available to the Institute for the Wright Brothers Lecture so that members and their guests may be accommodated. The meeting will be open without registration or any fees for those who wish to attend.

Necrology

Lt. James Douglas Hamm

Lt. James Douglas Hamm, U.S. Army Air Forces, was killed in action in North Africa on May 3, 1943. He had been engaged in active duty with a flight squadron since December, 1942, when he received his commission as a Second Lieutenant in the Air Forces.

Lieutenant Hamm was born at Charlottesville, Va., on February 16, 1920. After graduation from the Lane High School in his native city, he attended the University of Virginia and received the degree of Bachelor of Mechanical Engineering with Aeronautics Option, in June, 1940. He was then appointed Junior Research Engineer at Lockheed Aircraft Corporation at Burbank, Calif., and worked under Dr. W. M. Bleakney on flutter research. His work consisted basically of developing calculation methods and carrying out flutter analysis on current airplanes and new designs.

He collaborated with Dr. Bleakney in the preparation of a paper "Vector Methods of Flutter Analysis," which was published in the October, 1942, issue of the JOURNAL OF THE AERONAUTICAL SCIENCES.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Aeronautical Engineers urgently needed by Consolidated Vultee Aircraft Corporation, Fort Worth Division, to execute program of extensive development of large aircraft. Applicant must have technical training and not presently employed in essential war industries. Apply direct to 921 Lamar Street, Fort Worth, Tex.

Graduate Engineers for essential war work, opportunity for advancement and increased earnings. Aeronautical experience not necessary. Must be citizen not employed in essential war industry or have certificate of availability from the U.S. Employment Service Office or War Manpower Commission of your area. Write direct, stating school, age, degree, experience, draft classification, and marital status to Consolidated Vultee Aircraft Corporation, Industrial Training Division, San Diego, Calif.

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Writer with engineering background by established metal producer for technical editing and promotion work. Position in New York City offers sound future. Give full details including draft status. Address inquiries to Box 197, Institute of the Aeronautical Sciences.

AVAILABLE

Test Pilot, research minded, seeks new connection preferably in experimental or development work. Address inquiries to Box 201, Institute of the Aeronautical Sciences.

Aeronautical Engineer, B.S. in Ae.E., age 26, 2 years' experience stress analyst and structural engineer with Navy Department; possesses valid commercial, instructor, instrument and 675-hp. ratings; 1,300 hours time. Desires position involving flight engineering and testing. Address inquiries to Box 200, Institute of the Aeronautical Sciences.

Engineer, 15 years' experience as aeronautical, automotive, and air-conditioning engineer; until recently supervisor of important liaison work in engineering department of major aircraft manufacturer; at present doing graduate work in air transport field while acting as supervising research engineer on war project at University; desires connection in air transport field. Address inquiries to Box 199, Institute of the Aeronautical Sciences.

Graduate Engineer, 10 years' practical experience in design and development of aircraft armament including power-operated gun turrets; 50-caliber and 20-mm. fixed installations. Experience obtained with leading American and British Gun Turret Builders; desires position as Design Engineer or Executive with progressive aircraft concern. Address inquiries to Box 198, Institute of the Aeronautical Sciences.

Aeronautical Engineering Executive, 9 years' experience, all phases aircraft engineering; 10 years', mechanical engineering; 5 years', electrical engineering; 4 years', marine engineering; desires responsible executive position; immediately available. Address inquiries to Box 195, Institute of the Aeronautical Sciences.

Structural Aeronautical Engineer, 25 years' experience, military aircraft engineering including analysis, design supervision, liaison and coordination of experimental and engineering; desires responsible project with company having definite postwar work. Available within 30 days within radius of 200 miles of New York. Address inquiries to Box 194, Institute of the Aeronautical Sciences.

Engineer, Senior Aeronautical and Physicist (Ph.D.), 15 years' experience, available as a day to day consultant. Address inquiries to Box 189, Institute of the Aeronautical Sciences.

Aeronautical Engineer, M.I.T. graduate, age 37, 14 years' practical and well-rounded experience on aircraft design, supervision, executive; wide organization background. Held positions as project engineer, assistant chief engineer, chief aeronautical engineer. Desires permanent position as chief engineer or similar. Willing to go into partnership. Location preferred, Los Angeles or extended area, or South America. Address inquiries to Box 153, Institute of the Aeronautical Sciences.

(*Continued from page 153*)

Propellers

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859 Weinig, F. *Static thrust measurements on large propellers.* Jahrbuch der deutschen luftfahrtforschung, v. 1, 1937, p. 404–409. 13 p.

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Changes of Address

To facilitate the prompt receipt of copies of the Journal and Review, members and subscribers are requested to give the editorial offices 30 days' notice of any change of address.

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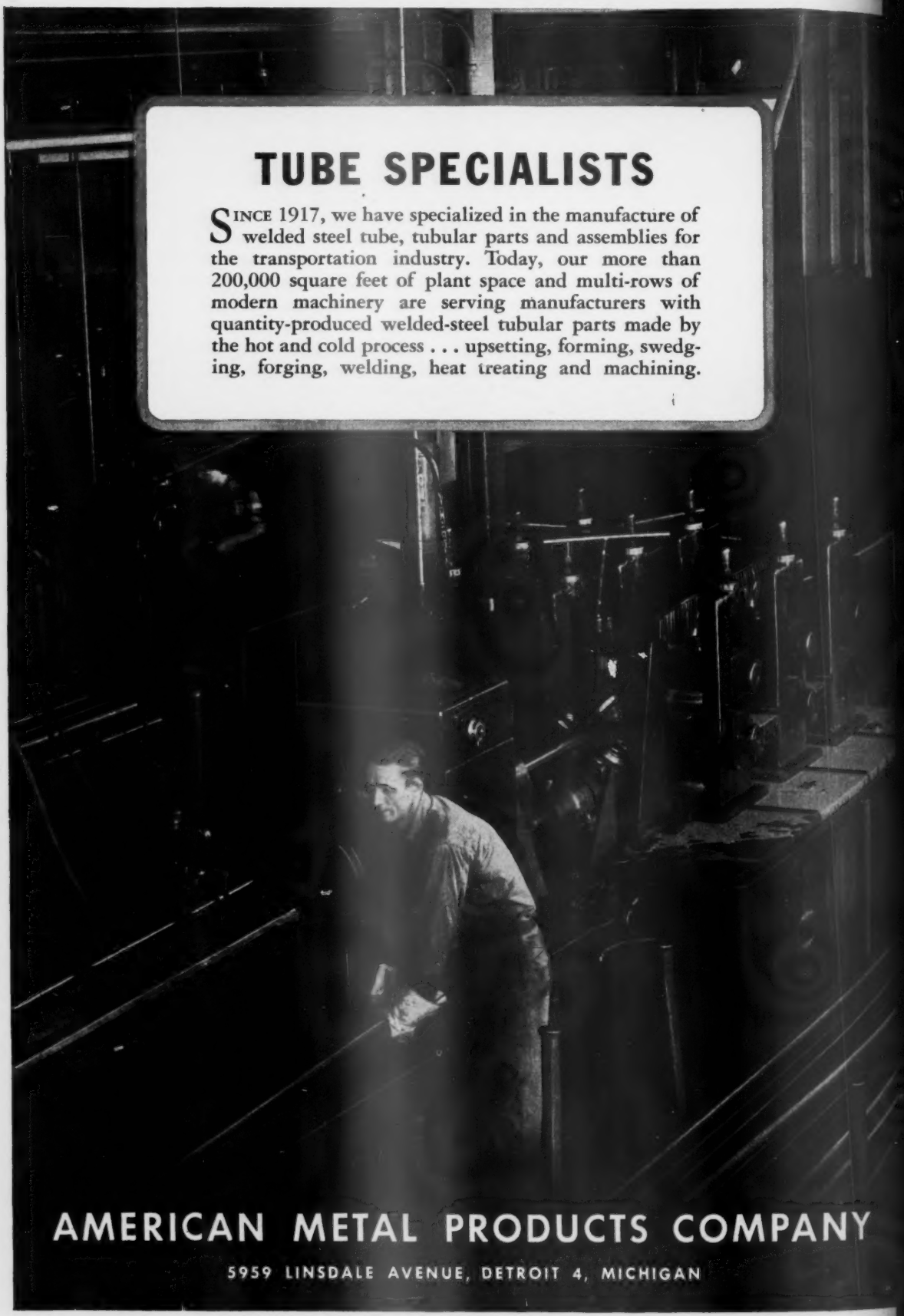
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